Understanding the Psychosocial Drivers of Adoption and Use of Mobile Mental Health Interventions Among Older Adults

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Abstract

Depression is a major mental health problem in the UK and is particularly problematic within older adults. In addition, tackling the symptoms of depression in older adults is hindered by specific barriers that older adults face in the access of mental health care. Mobile mental health interventions (MMHIs) provide a number of benefits for the delivery of mental health interventions due to their accessibility and thus, are able to overcome a number of barriers to mental health treatment. Existing research has explored ways in which use of MMHIs can be encouraged among a wide variety of demographic groups, including students, adolescents and adults, along with the psychological determinants of future use of MMHIs. However, older adults are seldom included in such research, despite being an age group that could benefit from MMHIs. This thesis aimed to address these gaps by investigating factors which may hinder older adults' access to such interventions and explore how older adults' perceptions of MMHIs may be improved. These research objectives were explored using a mixed methods approach.

First, this thesis qualitatively explored the psychological barriers that older adults who use technology may experience in the uptake and use of MMHIs. These findings laid the foundation for a series of three quantitative, survey-based studies. The second study took a quantitative approach in investigating the influence of these barriers on their attitudes towards MMHIs, and identified perception of data security, perceived effort expectancy and awareness of mobile mental health as key determinants of attitudes. Next, the Technology Acceptance Model (TAM) was applied to the three identified determinants of attitudes to present an adapted Technology Acceptance Model. In this adapted model, perception of data security was a valuable addition and showed significant associations to attitudes and intention to use MMHIs for older adults. Finally, an experimental study was conducted to compare the effects of different types of information about data security practices on improving older adult's intentions to use MMHIs, and their attitudes towards them.

This thesis has resulted in new knowledge about factors which are important for older adults in the uptake of MMHIs and highlights the role that perceptions of data security, expected effort requirement and awareness of current interventions might play in shaping their uptake by older adults. These findings are discussed in the context of existing literature and the implications for theory, current mental health care delivery and design of MMHIs.

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Acknowledgements

Authors Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval for each study contained within the thesis has been sought and granted by the Faculty of Health and Life Sciences Ethics Committee at Northumbria University at Newcastle.

I declare the Word Count of this Thesis is: 46,002

Name: Jake Thomas Pywell

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Publications Arising from Thesis

Work from this thesis has contributed to the following publication:

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Chapter 1: Thesis Overview

Depression is one of the leading causes of disability and affects approximately 264 million people worldwide (World Health Organisation, 2020). By 2030, it is expected that almost half of all patients with mental illness will be older adults (Jeste et al., 1999; Moussa et al., 2017). While depression is a prevalent mental health disorder throughout the lifespan, prevalence rates peak in older adulthood (World Health Organisation, 2017a). In the United Kingdom (UK), the prevalence rate of depression in adults is estimated to be 9.7% (Office for National Statistics, 2020) with further estimates suggesting that 14% of older adults over 55 years of age have depression, with that figure rising to 20% if sub-clinical symptoms are considered (Kok & Reynolds, 2017). Despite the prevalence of mental health issues, older adults typically do not receive help for mental health issues, with estimates suggesting that 87% of older adults with depression receive no help from the National Health Service (NHS) for depression symptoms (Mental Health Foundation, 2018). There are a number of reasons for this, namely the fact that older adults experience unique barriers in accessing mental health care such as mobility issues, low referral rates and various social factors (Brenes, Danhauer, Lyles, Hogan, & Miller, 2015). As mental health services face unprecedented demand, the need for alternatives to traditional face-to-face treatments becomes more important than ever, especially after the COVID-19 pandemic (Torous, Myrick, Rauseo-Ricupero, & Firth, 2020).

Mobile Mental Health Interventions (MMHIs) are a viable alternative to face-to-face mental health intervention and help overcome a number of barriers to access evidence based mental health care (Casey & Clough, 2016). Indeed, the NHS recognise the value of MMHIs in addressing mild to moderate mental health symptoms by making it a central consideration for their five-year plan (NHS England, 2017). Despite the promising evidence for the use of MMHIs in terms of clinical efficacy, evidence suggests that uptake rates remain low (Apolinário-Hagen, Kemper, & Stürmer, 2017; Mol, Genugten, Dozeman, & Schaik, 2020; Waller & Gilbody, 2009). Resultantly, identifying and overcoming barriers of use have become a focus of recent research, including identifying determinants of use and improving acceptance through 'acceptance facilitating interventions' (Apolinário-Hagen, Fritsche, Bierhals, & Salewski, 2018; Baumeister et al., 2014, 2020; Ebert et al., 2015).

However, older adults are underrepresented in MMHI research (Crabb et al., 2012) and are often not referred to digital mental health services by General Practitioners (GP) in primary care due to a belief that it will not be beneficial (Berry et al., 2019). On the contrary, older

adults are the fastest growing group of users online and are proficient users of technology (Vroman, Arthanat, & Lysack, 2015). They are interested in using technology to support health (LeRouge, Van Slyke, Seale, & Wright, 2014) and show positive attitudes towards using technology to maintain mental health (Andrews, Brown, Hawley, & Astell, 2019). Even though MMHIs represent a huge opportunity to address the shortfall in mental health care for older adults, the uptake and use of such interventions remains low. This problem presents a number of interesting questions that inform this research project.

1.1 Research Objectives

The specific objectives of this thesis were to:

- Identify factors that are associated with future use of MMHIs for older adults (Study 1, 2)
- Examine how identified predictors of older adult's attitudes towards MMHIs relate to intentions to use, using existing technology acceptance theory (Study 3)
- Explore whether perceptions of MMHIs can be changed in older adults by manipulating factors identified in studies 1-3 (Study 4)

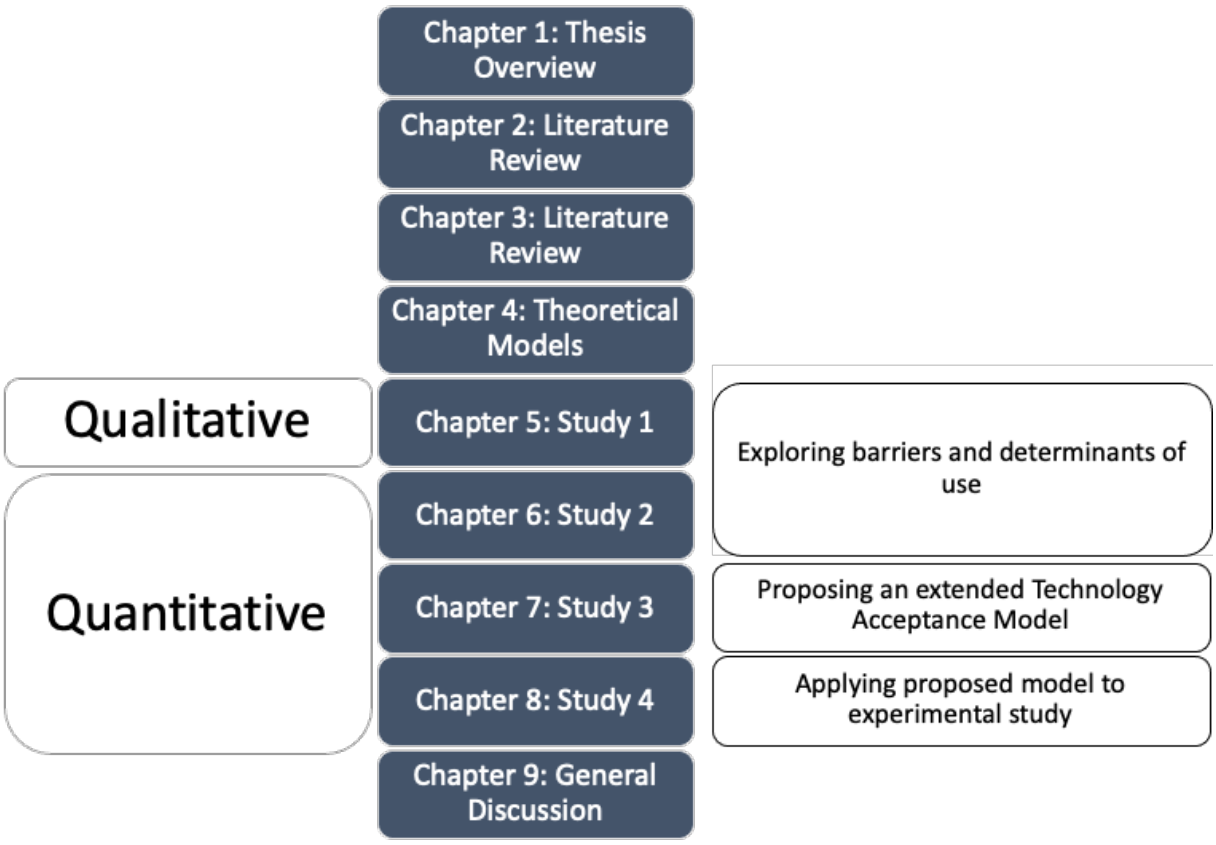


Figure 1: Thesis Approach and Chapter Overview

As seen in Figure 1, this thesis aimed to examine the factors that influence the uptake and acceptance of MMHIs among older adults. Study 1 aimed to explore the barriers that older adults are currently experiencing in the uptake and use of MMHIs. Study 2 aimed to identify significant predictors of older adult's attitudes towards MMHIs. Study 3 aimed to explore how the identified predictors of older adult's attitudes translates to determinants of acceptance, through a Technology Acceptance Model perspective. Finally, study 4 developed an intervention to increase intentions to use MMHIs for older adults by addressing misconceptions and providing education about such programs to improve awareness.

1.2 Overview of Studies

A mixed methods approach was adopted to explore the research objectives of this thesis. The research began by building upon previous literature by focusing on exploring the psychological barriers to use of older adults who already own technologies as this group are more likely to use MMHIs, rather than structural barriers such as technology ownership, which has been the focus of previous literature (chapter 5, study 1). The thesis then found that some of these barriers actually influenced older adult's perceptions of MMHIs and their attitudes towards them (chapter 6, study 2). Having found that the greatest predictor of attitudes toward the use of MMHIs was concerns over data security, effort expectancy and awareness of interventions themselves, the thesis then proposes an extended Technology Acceptance Model to accommodate these additional predictors, while aligning with existing theory (chapter 7, study 3). Once it was identified that perception of data security explained a significant amount of variance of attitudes towards use and intentions to use, an experimental study was developed to improve awareness of MMHIs but also to empirically test the role that perception of data security plays in the formation of attitudes towards MMHIs and older adult's intentions to use MMHIs (Chapter 8, study 4). The sections below provide an overview and the key findings of each study conducted within this thesis.

1.2.1 Study 1

Study 1 was a qualitative study that aimed to identify and explore the current barriers that older adults experience in the uptake of MMHIs. As previous literature had identified the importance of psychological barriers for younger age groups and given that technology use in the older adult age group is increasing, the focus of this study was on psychological barriers (e.g.

perceived effort requirement), rather than structural barriers such as ownership of technological devices. Thematic analysis was used to analyse the data from semi-structured interviews from 10 participants, who were all older adults, retired and over 50 years of age. The themes were organised using the Social Ecological Model framework which comprises of five levels: the individual, interpersonal, institutional, community and organisational level. The following six themes were identified: *interaction with technology,* which explored concerns of the technical skills required and computer self-efficacy. *Mental e-health awareness* which explores the fact that older adults do not know about mobile mental health resources which in turn leads to a lack of trust in them. *Discontinuation,* which describes how the effort requirement and lack of results may stop use of MMHIs. *'Seeing' facilitates the therapeutic alliance,* which explores how 'seeing' the therapist was important for older adults in terms of therapeutic results and also to facilitate trust. *Incongruent role of the General Practitioner,* which highlights how older adults had conflicting views of their GP as they felt as though their GP was their first port of call for mental health issues but did not feel confident in their ability to help. Finally, *privacy and confidentiality* highlights how older adults require privacy of their sensitive mental health information but also privacy of 'the self' and their need for anonymity when engaging in MMHIs. This study highlighted the range of factors hindering use of MMHIs for older adults and provided a number of suggestions for how these can be overcome.

1.2.2 Study 2

Study 2 took a quantitative approach and aimed to identify important predictors of older adults' attitudes towards MMHIs. This study was informed by the Technology Acceptance Model which identifies attitudes as an important predictor of intentions to use technology. As little is known about the determinants of older adult's attitudes towards MMHIs, barriers from study 1 (chapter 3) were operationalised into quantitative variables by using validated scales along with scales adapted from existing literature. An online questionnaire was completed by 298 older adults who lived in the UK, were retired and at least over 50 years of age. Regression analysis identified effort expectancy, perception of data security and e-awareness as significant predictors of older adult's attitudes towards MMHIs. This study also looked at current levels of MMHI use within an older adult sample and current awareness of MMHIs. This study provides quantitative support for the assumption that MMHI uptake is very low among older adult populations and identifies key variables that are determinants of older adult's attitudes towards MMHIs.

1.2.3 Study 3

Building from studies 1 and 2, study 3 applied the Technology Acceptance Model to explore whether e-awareness, effort expectancy and perception of data security were significant predictors of older adult's attitudes and made a meaningful addition to the theory surrounding technology adoption within the large context of MMHI uptake. Three hundred and twenty-one participants completed an online questionnaire consisting of scales designed to measure each construct of the technology acceptance model (perceived usefulness, perceived ease of use (also known as effort expectancy) attitudes and intention to use), along with the other two identified determinants of older adults' attitudes towards MMHIs: e-awareness and perception of data security. Structural Equation Modelling confirmed a good model fit and the proposed model remained consistent with the Technology Acceptance Model. Perception of data security was also a significant predictor of attitudes and had an indirect relationship with intention to use – mediated by attitude. These findings suggest that perceived usefulness, perceived ease of use, and perception of data security are all important factors in the formation of older adult's attitudes towards MMHIs but also integral determinants of their intentions to use MMHIs. This provides support for the use of the Technology Acceptance Model within the context of mobile mental health interventions. Furthermore, by revising the Technology Acceptance Model to include perception of data security, greater insight into the determinants of older adult's intentions to use can be gained by identifying which factors explain the most variance in intentions to use MMHIs.

1.2.4 Study 4

This experimental study builds on the findings of studies 1, 2 and 3. The aim of this final study was to investigate how providing general information about MMHIs and information about privacy and security of MMHIs to improve knowledge and awareness can impact on older adult's intentions to use MMHIs and their attitudes towards them. An intervention was developed which was informed by previous literature and the first three studies in this thesis. The experimental stimuli were designed to look like an NHS website, as study 1 indicated this would elicit a sense of trust in the information. Three hundred and forty-one participants were randomised between four groups, which received different types of information about data security: positively framed, negatively framed, both positively *and* negatively framed, and a control group which received no information about data security. Measures for the adapted Technology Acceptance Model presented in study 3 were taken pre intervention and post intervention. Mixed Analysis of Variance (ANOVA) revealed that participants intention to use,

attitudes, perception of data security and perceived usefulness were all significantly reduced as a result of negative data security information. Providing information about MMHIs increased intentions to use, attitudes, perception of data security and perceived usefulness for the positive data security condition and the control condition. This study showed that the NHS webpage was successful at improving determinants of use and may be an effective method of improving implementation efforts for older adults. This study also confirms that perception of security remains an important consideration for older adults in the uptake of MMHIs.

1.3 Original Contributions of the Thesis:

The original contributions of this thesis:

1. Identified barriers that older adults who are good technology users experience in the uptake of MMHIs and suggested ways to overcome these (study 1)
2. Explored the significant predictors of older adult's attitudes towards MMHIs (study 2)
3. Extended theory to apply the Technology Acceptance Model to the mobile mental health context (study 3)
4. Extended theory to propose an extended Technology Acceptance Model that includes perceptions of data security (study 3)
5. Demonstrated the importance of improving knowledge and awareness of MMHIs through an Acceptance Facilitating Intervention (study 4)
6. Demonstrated that the presence of data security information, and the polarity of such information, can change older adult's intentions to use MMHIs along with other important determinants of use (study 4)

Chapter 2: Literature Review: Background of the Problem

This chapter reviews the state-of-science for MMHIs as a potential solution to address the current shortfall in mental health treatment delivery for older adults. This chapter is split into three main components. The first provides an overview of the ageing population and how this poses an issue for health care of the future. The second introduces the problem of mental health in older age, along with risk factors and current treatments for mental health diagnoses in later life. The third section introduces MMHIs as a solution for the deficit of mental health care delivery and reviews evidence for their use.

2.1 An Ageing Population

The global population is ageing. In 2015, the World Health Organisation (WHO) estimated there are approximately 900 million adults aged 60 and above, with this expecting to rise to two billion by 2050 (WHO, 2018). In the United Kingdom (UK), adults aged 50+ account for 37% of the population, with this figure expected to rise to 39.5% of the population by 2027 (Office for National Statistics, 2018). This rise in the number of older adults has been largely attributed to advances in technology, medicine, socioeconomic development which has substantially reduced disability and mortality rates across the globe (Lunenfeld & Stratton, 2013).

Along with the ageing population and increased healthcare risks, comes an increase in healthcare expenditure. In the UK, healthcare costs are expected to grow from 7.3% to 8.3% of Gross Domestic Product (GDP) between 2019/20-2064/65, an increase of £79 billion attributed largely to the ageing population (Government Office for Science, 2019). This requirement for an increase in healthcare funding is a result of the fact that healthcare costs are generally associated with age. In the UK, government healthcare spending increases rapidly from approximately £2000 per person at 50, to almost £10,000 per person at 86+ (Public Health England, 2019). As a result of this, older adults are a vulnerable population who account for a disproportionate amount of healthcare spending compared to younger ages.

While ageing is a natural process, there is no denying that decline in physical health creates large demands for health care services. Older adults experience a number of physical health conditions that contribute to the provision of health care expenditure. Khan, (2019) describes how older adults are at a disproportionate risk of noncommunicable diseases (including heart disease, stroke, cancer, diabetes and dementia) but are also likely to suffer from

multimorbidity's whereby they experience a coexistence of two or more chronic physical conditions.

As a result of this, a recent focus on 'ageing in place' has dominated ageing literature. Older adults have shown a preference for ageing in an environment that is familiar, comfortable and manageable (Lesauskaitė et al., 2019). The concept of ageing in place has a number of benefits and with the focus on ageing in place as a health initiative, could see older adults remain in their homes, living independently for longer. This avoids the costly option of institutional care, and is therefore favoured by policy makers, health providers and by older adults themselves (Wiles, Leibing, Guberman, Reeve, & Allen, 2012). In order to achieve this, technology is being relied on to provide alternatives to healthcare that are accessible, mobile and usable to enable older adults to access these in the comfort of their own home.

With population ageing, the older adult age-group represent an age demographic worthy of investigation. As the number of older adults increase, the demand on health care systems will increase in parallel thus evidence-based solutions are required.

2.1.1 Defining Older Adults

While it is agreed that the general population of the UK, and globe, is ageing there has been disagreement over who exactly are 'older adults', with defining old age becoming increasingly difficult. In the UK, we often refer to the retirement age of 65. Indeed, the World Health Organisation have defined older adults as being over 60+ (World Health Organisation, 2018), with other mental health organisations viewing 'older adulthood' as starting at 50 (Mental Health Foundation, 2018). Additionally, some studies classify older adulthood into groups, such as the 'young-old' ranging from ages 65-75 and the 'old-old' ranging from ages 75+ (Mehta et al., 2008), or the use of generational groups such as 'baby boomers' who are usually considered to be born between 1946 and 1964 (Young & Tinker, 2017) and the silent generation, who are considered to be born between 1925 and 1945.

Despite the variability in age ranges used to define later life, the use of chronological age does not take into account other social factors that may relate to the life transition into later life. For example, retirement is often viewed to coincide with old age, however using the chronological age of 65 (retirement age in the UK) does not take into account those who voluntarily take early retirement or are forced into retirement due to the difficulties of finding employment after mid 50s (Wiles, 1987).

Consequently, chronological age may not be the most reliable marker of old age. Indeed, older adults are a vital part of a number of communities, remain socially active, and often do not see themselves as part of the 'older adult' age bracket (Righi, Sayago, & Blat, 2017). It has been recognised that using arbitrary chronological ages to define later life should not be used in research as to not perpetuate ageism (Vines, Pritchard, Wright, Olivier, & Brittain, 2015) and instead, look to other psychosocial factors to help define who falls into the older adult age group. In particular, retirement is a useful marker of later-life as this represents a major life transition with regard to health, housing, social interaction, work life and personal finance (Salovaara, Lehmuskallio, Hedman, Valkonen, & Nasanen, 2010).

As a result, this thesis will consider the relative benefits of both options of definition and considers older adults to be of a chronological age of 50+ and retired. This incorporates those who may have taken early retirement, individuals from the 'baby boomer' generation who are approaching retirement age, and those who are older and have been retired for many years. This approach to defining old age has been recently adopted by a number of studies as it encompasses broadly accepted definitions of both retirement and chronological age, but also ensures the research remains relevant and encompasses a broad range of accepted definitions (Andrews et al., 2019; Fox & Connolly, 2018).

2.2 Mental Health in Older Adults

Along with noncommunicable physical diseases adding to older adult's health concerns, mental health also plays a big role in the overall health of older adults. Older adults are prone to a number of different mental health disorders, with the World Health Organisation estimating that 20% of older adults suffer from a mental or neurological disorder, with anxiety disorders affecting 3.8% of older adults and 1% affected by substance abuse (World Health Organisation, 2017b). In a large-scale European study, findings suggest that mental health problems are prevalent in later-life. The findings show that the prevalence of mental health problems among older adults aged 55 and over in primary care was 19.1%, with depression, panic/anxiety disorder and alcohol/substance misuse being the top mental health diagnoses (McCombe et al., 2018). It is clear from these figures that older adults are just as likely to experience these common mental health disorders in later-life. Within the larger domain of mental health, depression is a particular concern due to the increased risk in later life and high prevalence rates.

2.3 The Issue of Depression in Older Adults

Despite older adults experiencing a number of common mental health diagnoses, depression in later life is the most common mental illness among older adults, and is projected to be the leading cause of disease burden in higher income counties by 2030 (Rodda, Walker, & Carter, 2011). Estimates show that nearly 14% of people older than 55 years of age have depression, with this number increasing to approximately 20% when sub-threshold depression is taken into consideration (Kok & Reynolds, 2017).

Psychological symptoms of depression include prolonged periods of low mood, suicide or self-harm ideation, feelings of guilt and worthlessness, insomnia, loss of interest in usual activities and feelings of hopelessness, whereas physical symptoms of depression include shortness of breath, fatigue, loss of appetite, weight loss and insomnia (Pocklington, 2017). The symptomatology of depression for the older adult demographic differs somewhat from the general population. Symptoms such as unexplained aches and pains, sleep disturbance, fatigue, loss of interest in living and hopelessness about the future are likely to be more prevailing in later-life depression (Rodda et al., 2011). Whereas affective symptoms such low mood are less likely to present in older adults – particularly men (Cherubini et al., 2012).

While these symptoms must be present for a period of at least two weeks for clinical diagnosis, they can also be present without a major depressive episode and which do not fulfil the clinical requirements. This is referred to as sub-threshold depression and is predicted to be two to three times more prevalent in older adults (Meeks, Vahia, Lavretsky, Kulkarni, & Jeste, 2011; Pocklington, 2017). For older adults, sub-threshold depression is important as it is associated with worsening health, risk of cognitive impairment, risk of physical disability and is associated with increased health care costs with 8-10% of older adults per year with subclinical symptoms developing a major depressive episode (Cherubini et al., 2012; Meeks et al., 2011).

Although these symptoms are widely known, older adults' symptoms are often described as "secondary" or "masked" as they may initially appear to be cognitive impairment or are mistaken by older adults themselves, and health care professionals, to be merely 'signs of ageing' (Chapman & Perry, 2008; Silfvernagel et al., 2017). Cherubini et al., (2012) also describe a diagnostic issue for older adults in that the Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria does not account for many of these "masked" symptoms that are reported by older adults. Therefore, the prevalence rate of depression in older adults is likely to be underestimated.

Furthermore, due to limited number of trained psychotherapists, a lack of help seeking behaviours displayed by older adults, stigma and long waiting times, depression is not always treated (Drozd et al., 2016; Rost et al., 2017). For example, in England, one in ten people wait more than a year for a mental health assessment (Bennion, Hardy, Moore, & Millings, 2017) with 85% of older people receiving no assistance from the NHS for mental health conditions. These trends are significant given that depression is associated with reduced quality of life, increased disability and increased risk of suicide in the elderly (Titov et al., 2016). Even relatively minor levels of depression can lead to a significant decrease in quality of life and negative attitudes towards ageing (Chachamovich, Fleck, Laidlaw, & Power, 2008). It is clearly of great importance to increase older adult's access to mental health treatment.

2.4 Risk Factors

While depression is becoming the most prevalent mental health disorder on the planet across all age demographics, older adults are particularly vulnerable. Depression in later life has been described in terms of diminished reserve capacity – meaning older adults have a lack of resources to cope with stressors (Lohman, Dumenci, & Mezuk, 2016). This is significant as older adults experience a wide range of stressors in later-life which may contribute to the overall development of depression in later-life.

Older adults experience a number of factors that increase the risk of depression. Fiske, Wetherell, and Gatz, (2009) outline a number of the risk factors which fit into three broad categories. The first is stressful life events such as financial difficulties, bereavement and physical illness or disability, second there are socioeconomic factors such as deterioration of financial status which may in-turn negatively affect nutrition, opportunities for education and access to healthcare and finally, social factors such as loneliness and isolation. These factors are also supported by a meta-analysis which identified bereavement, sleep, disability and prior depression as the most significant risk factors for depression for adults aged 50+ (Cole & Dendukuri, 2003).

However, research has recently challenged the assumption that later-life depression is caused solely by psychological factors and that pathophysiological processes, such as; cardiovascular, neuroanatomical, endocrine and immune responses may also contribute to the course of depression in later-life (Haigh, Bogucki, Sigmon, & Blazer, 2017). There is also evidence that specific physical health conditions such as chronic pain, heart disease and diabetes are experienced concurrently with depression, and so physical health of older adults is certainly a

major risk in the development of depression (Hazell, Smith, & Jones, 2019), with older adults experiencing high symptoms of depression having on average 3.8 additional chronic medical conditions (Harpole et al., 2005).

Clearly, physical health has an impact on older adult's mental health, however social factors also pose a risk to mental health in later life. Social isolation and loneliness are prolific social issues in later-life as physical health deterioration often limits older adult's ability to engage in social interactions and spousal bereavement may mean that older adults are oftentimes living by themselves (Adams, Sanders, & Auth, 2004; Pocklington, 2017). Furthermore, older adults also perceive loneliness to be a factor that leads into depression and that loneliness is closely associated with ageing (Barg et al., 2006).

2.5 Treatments for Depression in Later Life

A number of treatment options are available for older adults with depression. Treatment for depression in later-life is typically managed in primary care with a large proportion (approximately 87%) prescribed antidepressant medication (Frost, Bhanu, Walters, Beattie, & Ben-Shlomo, 2019). Typically, Selective Serotonin Reuptake Inhibitors (SSRIs) are chosen as the first line of antidepressant treatment as they have fewer side effects for older adults, however they are more susceptible to interactions with other medications which is an important consideration for older adults with polypharmacy (Kok & Reynolds, 2017). For those who take antidepressants, remission is achieved in roughly a third of all older patients (Kok & Reynolds, 2017), therefore there are two thirds of older adults who require additional treatment.

Despite antidepressants being a popular choice of depression treatment, they come with their risks for use in older populations. As older adults often have comorbid conditions, they are often excluded from trials and therefore less is known about adverse effects of drugs in the older population compared to younger age groups (Coupland et al., 2011). As a result, Coupland et al., (2011) conducted a cohort study with data from 570 general practices in the UK and found that SSRIs were associated with higher incidents of falls and hyponatraemia. Antidepressants were also found to cause higher incidents of mortality, attempted suicide/self-harm, stroke, fracture and epilepsy/seizures compared to when antidepressants were not used. As a result, although antidepressants may be effective in reducing symptoms of depression, when used for older adults, other physical health concerns and side effects of the medication need to be considered.

Along with antidepressants, psychotherapy is also an effective form of therapy for older adults. Talking psychological therapies have been shown to be effective in older adults. Cognitive Behavioural Therapy (CBT) is the most common form of psychotherapy in the UK, with strong evidence that CBT is effective for older adults for treatment of depression (Cuijpers, Karyotaki, Pot, Park, & Reynolds, 2014). Evidence also suggests that CBT can be effective for older adults in a group setting (Krishna et al., 2011) and as a result older adults have a variety of treatment options when it comes to psychotherapy in the UK. Despite its effectiveness, CBT does not come without its limitations when treating older adults. Research has argued that the cognitive components of CBT therapy are less effective in older adults, and treatment should instead focus on behavioural techniques such as relaxation therapy (Oude Voshaar, 2013).

In the UK, a large-scale scheme for Improving Access to Psychological Therapies (IAPT) was released in 2007 within the NHS. This scheme is based on a stepped-care model and aimed to improve access to evidence-based psychological therapies for people with mental health problems (Clark et al., 2009; Laake, Parratt, & Majeed, 2020). Within the stepped-care approach, the IAPT scheme focuses primarily on step 2: treatment of mild depression in primary care, and step 3: treatment of moderate to severe depression in primary care (Prina et al., 2014). Despite the IAPT scheme being offered to all adults, evidence suggests that older adults are significantly underrepresented. Prina et al., (2014) conclude that older adults account for only 4% of all IAPT referrals made within a two-year period of data collection within the Eastern Region of the UK. Furthermore, Chaplin, Farquharson, Clapp, and Crawford, (2015) conducted a study with 220 services across 97 primary care organisations and found that only 6.4% of records were older adults. The study also found that older adults were significantly more likely to decline therapy or deemed not suitable for psychological therapy. Despite this, the evidence suggests that psychological treatment was effective for older adults and were more likely to complete the therapy provided.

This is an important consideration for the treatment of depression in older adults as older adults show a higher preference for talking therapies than antidepressants and yet, older adult's access to talking therapies is low despite its effectiveness and older adult's willingness to engage in this form of mental health treatment (Frost, Beattie, Bhanu, Walters, & Ben-shlomo, 2019).

2.6 Barriers to Mental Health Treatment for Older Adults

The low numbers of referral rates and treatment rates of older adults can be attributed to a number of factors that act as barriers to older adults receiving mental health care. The

Department of Health have identified a number of barriers that prohibits older adults from accessing mental health care through the IAPT scheme. Firstly, older adults experience physical ailments such as mobility issues, disability and sensory problems which may hinder their access to primary health care. Secondly, there is a perception among older people and health and social professionals that psychotherapy would not be relevant for older adult's problems which may prevent further referral to additional mental health services. The final issue highlighted is that staff who work within mental health services are not trained to specifically work with geriatric populations, and that they lack understanding and confidence when working with older adults (Department of Health, 2013).

Along with Government reports, barriers to receiving mental health support for older adults have been highlighted within the literature, with barriers to accessing mental health treatment in later-life being documented at all stages of care; from accessing a GP, getting a diagnosis, then receiving and maintaining treatment. The behavioural model of health service use details how contextual and individual factors may influence mental health service use for older adults (Andersen, 2008). In particular, phase five of the model outlines the contextual factors that are likely to effect service use, such as the fact that older adults are less likely to receive social support and advice to seek help and are prone to mental health policies that impede access to care. Similarly, individual factors that affect access to care for older adults include predisposing factors such as demographic factors (for example, age and gender), enabling factors such as social support along with subjective and objective indicators of need for help.

However, Andersen's model has received criticism as it does not adequately account for personal belief barriers that older adults may hold (Volkert et al., 2018). Researchers have identified additional factors that affect mental health help-seeking among older adults. For example, in a large scale quantitative study, Brenes, Danhauer, Lyles, Hogan, and Miller, (2015) highlight how older adults are less likely to perceive themselves of needing professional mental health support and had a mistrust of mental health providers and had no desire to talk to a 'stranger' about personal matters, as well as concerns over stigma and embarrassment. Additionally, social isolation, disability and views, beliefs and attitudes have been identified as additional factors that may prevent older adults from recognising mental health problems as conditions that require treatment (Chaplin et al., 2015). Finally, lower levels of service use are associated with older age and poor mental health literacy which is typically the case in older adults (Mackenzie, Pagura, & Sareen, 2010). Collectively, these factors may prevent older

adults from identifying their need for mental health care and also accessing that care once the decision has been made to seek help.

Further contributing to the disproportionate level of mental health care for older adults is the role of the GP. In the UK, GPs have been labelled as 'gatekeepers' to IAPT services for older adults, as GPs are responsible for the majority of referrals to the IAPT scheme (Berry et al., 2019; Pettit et al., 2017). There are a number of reasons why GPs may hinder access to mental health care for older adults. Research shows that GPs have an ageist attitude towards treating older adults with talking therapies with the view that they may be 'too old' to change (Berry et al., 2019; Robb, Chen, & Haley, 2002). Additionally, research reports that older adults believe their GP is not an appropriate health care professional for feeling mentally distressed, offer little else than medication or antidepressants and that GPs do not have time to treat older adults (Chew-Graham et al., 2012). However, some researchers argue that help-seeking attitudes and treatment beliefs are unlikely to contribute to the overall disproportion of service use among older adults (MacKenzie, Scott, Mather, & Sareen, 2008).

The evidence suggests that there is a huge demand for evidence based mental health services in later life, and yet there are a number of barriers that prevent older adults from receiving this mental health care. The evidence presented displays a clear disparity in mental health care in later life, despite the fact that treatments are evidence based and efficacious. The disparity of mental health care provisions is also expected to continue with the ageing population unless alternative evidence-based alternatives are found.

2.7 Mobile Mental Health Interventions

The use of technology to provide mental health support has become an attractive solution to address the shortfall in mental health provisions. The use of technology is not a new innovation, with modes of delivery changing from traditional CD Rom packages on standalone PCs to ubiquitous smartphone applications (apps), these digital therapies are receiving increasing interest – particularly in light of the COVID-19 pandemic (Torous et al., 2020).

Mental health intervention delivered through technology are generally referred to as 'e-therapies'. E-therapies are broadly defined as "the use of Information and Communication Technology (ICT) – in particular, the many technologies related to the internet – when these technologies are used to support and improve mental health conditions and mental health care" (Riper et al., 2010). This definition offers particular strengths as it encapsulates the vast

majority of delivery methods such as traditional ICTs such as desktop computers, but also contemporary delivery modes such as through smartphone apps. However, as technology has advanced, the focus is increasingly moving towards smartphone apps as they are more mobile and accessible and are deemed an acceptable method of mental health care delivery (Weisel et al., 2019). The available smartphone apps can be further defined into distinct groups based on how much therapist involvement there is. Applications without therapist support are self-guided, whereby the user works their way through the intervention on their own, whilst guided apps are ones that involve a trained mental health professional who guides and motivates the user through the intervention (Urech et al., 2018).

It is recognised within the literature that terminology is inconsistent when describing digital interventions, with terms often used interchangeably (Apolinário-Hagen et al., 2017; Oh, Rizo, Enkin, & Jadad, 2005). This creates issues for systematic reviews when deciding on search terms and has thus been referred to as "terminology chaos", with the issue expecting to be exacerbated by the fact smartphone delivery and virtual reality are beginning to be combined with the more standard internet delivery and thus, the 'recognised' terminologies (Andersson, Titov, Dear, Rozental, & Carlbring, 2019). As a result, digital interventions are referred to within this thesis as 'Mobile Mental Health Interventions' (MMHIs) as this reflects the fact that interventions can be accessed through smartphones which are indeed, mobile, and encompasses the range of available interventions that are accessible through the internet and through smartphone apps. As smartphones become more sophisticated and ubiquitous, it is likely that mobile devices such as tablets and smartphones are the predominant route to access digital interventions. Consequently, the terminology used in early literature to describe CBT delivered through a computer (cCBT) or the internet (iCBT) are no longer appropriate but will continue to be referred to as such throughout this thesis when discussing specific literature.

2.7.1 MMHIs Within the NHS

Within the IAPT scheme, a small number of mobile apps are within the stepped care model for mild to moderate depression, following National Institute of Clinical Excellence (NICE) guidelines. At the time of writing (2020) there are currently 18 apps under the mental health section which focus on a variety of different mental health issues, such as: depression, anxiety, stress, phobias, panic and self-harm. There are five apps available that utilise CBT principles, however there are only two that specifically address mild to moderate depression. Currently, NICE guidelines stipulate that digital CBT can be offered to persistent subthreshold, or mild to

moderate depression however rather than recommend any specific programmes, NICE instead provide general guidelines for computerised-CBT (cCBT) (National Institute of Clinical Excellence, 2009). As such, the NHS apps-library is populated with a number of different apps all with different features. Bennion et al., (2017) provide the first attempt to document all of the e-therapies used and recommended by the NHS.

2.7.2 Advantages of MMHIs

Alternatives to traditional face-to-face research have been a focus for the last two decades, and Andersson, (2014) describes three distinct reasons why alternatives to face-to-face delivery are required. First, there are not enough trained specialist clinicians to meet the high demand of people presenting with mental health symptoms. Second, logistical barriers such as distance to specialist clinics and allocating time for appointments, taking time off work and finding childcare cover may prevent access to appointments. The third reason Andersson proposes is preference. Some people may simply prefer digital delivery of mental health intervention, and delivery at distance may reduce stigma.

Furthermore, MMHIs are a useful service to implement as they offer a number of benefits to health services over traditional face-to-face therapy. Namely, increased accessibility due to the fact that the content can be accessed anywhere and at any time, flexible use, cost benefits to both user and provider, along with potential to reduce waiting times and provide anonymity which reduces fear of stigmatisation (Schröder, Berger, Westermann, Klein, & Moritz, 2016). They also offer additional benefits such as their ability to reduce practitioner time to achieve comparable outcomes to face-to-face therapy (Gun et al., 2011).

2.8 Chapter Summary

In summary, the current evidence on mental health in older adults provides an overview of the current treatment options and barriers that older adults face in accessing these treatments. The treatment of mental health issues in older adults is clearly facing a huge shortfall, and access to mental health care for older adults is reliant on a number of different factors. However, MMHIs represent an opportunity for older adults to access mental health support that is accessible, anonymous and effective which overcomes a large number of barriers they currently experience. The next chapter will review literature focusing specifically on MMHIs within the older adult population, focusing first on the effectiveness of such interventions in the general population and then older adults, before considering the suitability of MMHIs for older adults.

Chapter 3: Literature Review

3.1 Effectiveness of Mobile Mental Health Interventions

The evidence base for the use of MMHIs is quickly growing around the world, with recent meta-analysis showing that smartphone apps targeted at depression are effective at treating symptoms of depression, although effect sizes were small (Weisel et al., 2019). This meta-analysis mainly consisted of apps that were deemed 'self-guided' which have no support from a mental health professional and may therefore explain the small observed effect size. Nevertheless, this meta-analysis supports existing evidence. Grist and Cavanagh, (2013) conducted a meta-analysis and found that computerised CBT can be efficacious for low intensity therapy for common mental health conditions. Finally, a meta-analysis by Karyotaki et al., (2017) found that self-guided CBT for depression was effective in treating depression symptoms and the authors conclude that there is substantial evidence for the use of self-guided CBT as an evidence based first-step approach in treatment symptoms of depression.

Additionally, while a wealth of evidence comes from randomised control trials in comparison to control groups, several researchers have also aimed to investigate whether digital mental health interventions are comparable to face-to-face treatment. For example, a number of meta-analysis have found that guided MMHIs produce comparable results to face-to-face treatment for depression, and a number of other mental health conditions (Andersson, Cuijpers, Carlbring, Riper, & Hedman, 2014; Cuijpers, Donker, Van Straten, Li, & Andersson, 2010).

Furthermore, studies have been conducted to support the use of specific smartphone apps. For example, Proudfoot et al., (2013) conducted a trial of the 'MyCompass' program (known in the UK as 'My Possible Self'), which is a fully automated self-help smartphone application. The study shows that this smartphone application is highly effective at providing rapid improvements in mental health symptoms, including measures for depression. Additionally, Kinderman et al., (2016) conducted a trial to test the feasibility of 'Catch it' – a diary based application designed on CBT principles. Results in this study showed that, although overall uptake was low, the users did report a reduction in depression symptoms. These two studies are pertinent as these two apps are currently available on the NHS Apps Library and therefore represent an evidence base for some of the options for self-help apps in the UK.

However more recently, researchers have shown scepticism about the quality of mental health apps available to download and the accuracy of their quality claims with a number of apps

providing insufficient evidence to support their claims (Larsen et al., 2019). Additionally, a 2012 review by Crabb et al concludes that older adults are underrepresented in trials, which is a shortfall of the extant literature. In order for health care providers to benefit from the aforementioned advantages, digital interventions need to cater for, and be used by all demographics who require mental health services. As older adults set to benefit from this innovative delivery of mental health care, they represent a large oversight in the literature to date and it is in the interest of public health to ensure that older adults are considered as this research area grows.

3.2 Effectiveness of Mobile Mental Health Interventions in Older Adults

Studies examining the effectiveness of MMHIs in older adult samples began in 2007. After suggesting that subthreshold depression leads to similar degrees of impairment in health status and disability than those with a diagnosis of depression, Spek et al., (2007) aimed to investigate whether a course of CBT delivered through the internet was successful in improving symptoms in a sample of older adults (aged 50+) who experienced depression symptoms. The intervention was 'self-help' and involved no support from mental health professionals. The study also included a group of participants receiving a course of traditional face-to-face CBT and a waitlist-control group. The results suggest that the internet CBT course was effective in reducing depression symptoms, with a non-significant difference in efficacy to the traditional face-to-face CBT group. Furthermore, in a follow-up study one year after the start of treatment, it was found that CBT delivered online was significantly more effective at reducing symptoms than the control condition, thus suggesting that the effects of digital interventions for mental health in older adults result in prolonged improvements (Spek et al., 2008). Despite this study being conducted over a decade ago with advances in technology and older adult technology use observed since then, this study is regarded as the first Randomised Control Trial (RCT) to include older adults, and therefore this provides a strong base of evidence which informed later studies.

Since the review by Crabb et al., (2012), evidence has slowly began to emerge for the efficacy of MMHIs in treating depression symptoms for older adults. For example, the first trial conducted since Spek et al, 2007 originated from Australia where Dear et al., (2013) conducted a study to test the 'managing your mood' program for depression in a sample of older adults with clinical levels of depression. This program consisted of five lessons delivered over 8 weeks, with contact from a psychologist via email and telephone. The results showed that the

program resulted in significant improvements of depression symptoms measured by the Patient Health Questionnaire 9-items (PHQ-9) and the Geriatric Depression Scale – two popular measures of depression. The study also achieved high completion rates of the program. However, this study is limited due to the fact it was an uncontrolled open trial with a limited sample size (n=20).

Adding to this preliminary evidence, Titov et al., (2015) aimed to address the limitations of Dear et al, (2013) by conducting a more methodologically rigorous RCT, whilst also examining the longer term outcomes. It was found that the intervention group had significantly reduced symptoms of depression at post-treatment measures compared to the control group, which was maintained at 3 month and 12 months follow up.

Building on this evidence, Titov et al., (2016) investigated whether guided vs unguided vs unguided with pre-treatment interview interventions effected therapeutic outcomes for older adults using a digital trans-diagnostic intervention for anxiety and depression, called the 'Wellbeing Plus Course'. While all three groups displayed a reduction in depressive symptoms, they found no significant difference between the groups on symptom reduction, and this was maintained at a three month follow up. This finding brings into question whether older adults need close clinical guidance in order to achieve therapeutic outcomes on digital interventions. The authors highlight the importance of intervention design which include automated prompts that older adults can easily follow.

Additionally, Silfvernagel et al., (2017) investigated the effects of an individually tailored internet-based CBT for older adults with mixed anxiety/depression. The study again found favourable outcomes for the intervention group on measures of depression (Montgomery Åsberg Depression Rating Scale and the PHQ-9). However, compared to other literature, this study experienced higher rates of drop-out with 33% of the sample not completing post-treatment measures.

Furthermore, recent evidence comparing age groups in the efficacy of CBT delivered through technology found no significant differences in efficacy across three age groups (18-39, 40-59, 60+) (Pabst et al., 2020). This study is important for a number of reasons. First, it suggests that digital alternatives to mental health care delivery are a universal alternative to treating depression. This study also questions the assumption that MMHIs are not as suitable for older adults than younger adults, and as such they should be recommended equally. Second, this study shows that self-guided digital treatments recommended by the GP do not need additional

and elaborate clinical guidance to achieve clinically significant reduction in symptoms. Finally, this study highlights the discrepancy between expected and actual benefits of digital CBT in treating older adults and given the increasing use of technology among older adults, the authors call for further research to investigate the fears and doubts of older adults in using MMHIs.

This builds upon previous evidence which found that MMHIs are as beneficial for older adults as they are for other age groups. For example, Hobbs et al., (2018) conducted a study aiming to compare the effects of CBT delivered through technology across the adult lifespan. Similar to Pabst et al, (2020), they included a number of age groups ranging from 18-60 but instead broke age ranges down into more discrete categories for comparisons throughout the adult lifespan. Stratified age groups included: 18-24 years, 25-34, 35-44, 45-54, 55-64 and 65+, therefore capturing a range of ages across the lifespan. Participants completed a 12-week digital CBT programme along with additional 'homework' that accompanied each session. The findings show that the digital CBT intervention used in this study resulted in substantial improvements in mental health along with symptoms of depression. This finding was true for all age groups, including the 65+ age group. It was also found from the study that the older adult group were actually more likely to complete the treatment compared to younger adults, however it is not clear why older adults were more likely than younger age groups to complete the course of treatment.

Finally, other studies have looked at the use of digital mental health interventions to reduce symptoms of depression when diagnoses with a comorbid health disorder in older adults. O'Moore et al., (2018) conducted a study with the use of a digital CBT program for older adults, aged 50+, with osteoarthritis of the knee and comorbid depression. They found that the digital CBT program was successful in improving overall health of the participants, with participants also reporting improvements in osteoarthritis-related self-efficacy (pain, stiffness and physical function). This suggests that the CBT not only led to increases in mental well-being but benefits also extended beyond mental well-being to improving physical health and functioning. For the older adults included in the trial, O'Moore et al (2018) also reported high levels of adherence in the intervention, with an 84% completion rate of all six lessons.

This section presents studies which show emerging support for the digital delivery of mental health services and suggest that they are an effective way to deliver support for those with depression symptoms. However, these studies were not conducted in the UK, meaning

generalisability of findings to the UK is a consideration due to availability of differing digital interventions and the variety of different health care systems adopted by individual countries.

3.3 Suitability of MMHIs for Older Adults

Despite this emerging evidence of the efficacy of digital interventions for the treatment of depression and other mental health conditions in later life, there is an assumption that the use of technology for this purpose may be unsuitable for older adults. It is important to consider the suitability of mobile health for older adults as the risk of older adults being excluded from MMHIs increases (Seifert, Reinwand, & Schlomann, 2019) as adoption of mobile health in later life remains low (Fox & Connolly, 2018). Contrary to the belief of GPs and other health professionals, MMHIs are a suitable method of mental health care delivery in later-life as the assumption that older adults have poor technology use is challenged in mobile mental health literature (Cangelosi & Sorrell, 2014).

In order to ascertain the suitability of MMHIs for older adults, it is important to understand the burgeoning use of technology in this age group. The literature investigating older adults and technology use is peppered with discussion of the 'digital divide' which describes the disparity between age-groups regarding internet and ICT use. This is often because older adults have lower levels of digital literacy and therefore lack knowledge, skills or awareness of existing technologies, compared to their younger counterparts (Wu, Damnée, Kerhervé, Ware, & Rigaud, 2015). However, despite suggestions that older adults have limited knowledge and skills in the use of technology for mental health uses (Ennis, Rose, Denis, Pandit, & Wykes, 2012), more recent evidence suggests the contrary as competence of technology use in older adults is increasing, with older adults showing an increased interest in using technology to support mental health (Andrews et al., 2019), increased feelings of confidence in technology and readiness to use technology for health purposes (LeRouge et al., 2014). With regard to using technology for health in general, researchers suggest that older adults are not computer illiterate, they are merely different kinds of users of technology (Quan-Haase, Williams, Kicevski, Elueze, & Wellman, 2018).

Indeed, Seifert, Reinwand, and Schlomann, (2019) recognise that older adults represent an age group of different users and have therefore taken a different perspective. Rather than questioning whether older adults are suitable for MMHIs, the authors argue that MMHIs should be made and designed so that they are suitable for older adults. In order to achieve this approach, an understanding of the needs and perceptions of older adults is required along with

an understanding of older peoples experiences, expectations and concerns to ensure technologies are widely accepted (Spann & Stewart, 2018).

Furthermore, studies looking at the acceptability of MMHIs in older adults also show promising evidence of the suitability of the use of mobile technologies in the delivery of mental health care. Handley, Perkins, Kay-Lambkin, Lewin, and Kelly, (2015) investigated the familiarity with and intentions to use mobile mental health treatments amongst older rural adults in Australia and found that although awareness of digital interventions was low, those with greater knowledge of digital mental health programmes showed increased intentions to use them. Furthermore, after controlling for knowledge, the results showed that intentions to use digital mental health treatments were positively predicted by three factors: elevated distress, higher education and more frequent internet use, suggesting that targeting promotion efforts towards these characteristics may be effective in improving uptake.

For the older adults that do take part in trials, high levels of acceptability are reported, with high completion rates from participants in the older age groups (Schneider et al., 2018). This suggests that once older adults start a digital intervention, they are likely, or just as likely as younger people, to complete it and gain the benefits from the intervention. However, a limitation of this research area is that the older adults who participate in these trials are already seeking help for mental health issues and are competent in computer use in order to participate in the trials and therefore may not represent older adults who do not seek help (Seifert et al., 2019; Titov et al., 2016). As a result of this, it has been suggested that MMHIs may only be suitable for older adults who already own technology, are able to use the technology successfully and with additional technical support (Berry et al., 2019; Elsegood & Powell, 2008).

Though few studies have been conducted specifically looking at the acceptability of smartphones to specifically deliver mental health intervention to older adults, there is promising evidence for the use of smartphones in delivering care in other areas of health. Older adults have been shown to be keen to adopt mobile health (mHealth) in the treatment of physical health conditions and pain management, with high levels of acceptability (Parker, Jessel, Richardson, & Reid, 2013) and therefore the need to ascertain acceptability levels for the use of MMHIs in the treatment of mental health symptoms in older adults outside of a trial study environment remains a large gap in the literature.

3.3.1 Smartphone Apps and Mental Health Interventions

More recently, the focus of digital interventions has moved towards 'mobile health', defined as "handheld or wearable transmitting devices with multifunctional capabilities used to store, transmit and receive health information" (Kuerbis, Mulliken, Muench, Moore, & Gardner, 2017; Torous & Powell, 2015). This includes devices such as smartphones, tablets and wearable sensors. As a result, it is important to also consider the suitability of mobile technologies as a suitable delivery method for the delivery of mental health interventions.

Smartphones have been deemed an acceptable method of delivery of mental health care. Smartphones offer a number of advantages over other technologies for the delivery of mental health care. Namely, smartphones are small and portable and so can be used at the precise moment mental health intervention is required (Lui, Marcus, & Barry, 2017) and have been complimented as being a low cost and low burden way to engage older adults in health care services while alleviating the burden on health care services (Kuerbis et al., 2017). In particular, smartphones are an ideal method of service delivery due to the severe stigma related to mental health conditions and problems with transportation for older adults (Kuerbis et al., 2017). The use of smartphones represents an opportunity for older adults as ownership of smartphones is reaching unprecedented levels, with smartphone ownership continuing to rise dramatically among the older age group, with recent research showing that approximately 60% of older adults aged 50+ own a smartphone in the UK (Pew Research Centre, 2019). One study shows that, of those older adults that do own smartphones, they have evaluated this ownership as liberating and allows them to be more productive, whereas younger adults view smartphones more negatively and refer to it as 'a leash' (Kuerbis et al., 2017).

While it is clear that the level of technology use is increasing among the older age groups, preliminary evidence also suggests that they are also an acceptable delivery mode of mental health intervention for older adults. Fortuna et al., (2018) present a peer-delivered intervention with the use of a smartphone app to support delivery for older adults with serious mental illness. The results showed that the older adults found the smartphone app was accepted as a delivery method and is a useful resource to reinforce treatment outside of a clinical setting. Furthermore, the authors also note the additional benefits of the older adults being able to use the smartphone to access the intervention at any time and any location – a widely cited benefit of smartphones and their ability to be mobile. However, it must be noted that this study was a pilot study with a small sample size.

However, as smartphones and tablets have become ever more ubiquitous the research focus has shifted to mobile based apps as they offer a number of additional advantages such as accessibility, usability and convenience (Lui, Marcus, & Barry, 2017). Additionally, a review by Moussa et al., (2017) has found that mobile technologies such as smartphones and tablets are acceptable and feasible for older adults to use in the assessment of older adults with mental illness. The review also highlights that as the cost of smartphone technologies reduce in price, they are becoming ever more accessible and structural barriers such as cost may become less of a consideration as ownership of tablets and phones increases (Torous et al., 2014).

While it is clear that smartphones offer a number of advantages as a delivery method for MMHIs over other, more traditional methods, they are not without their own unique barriers. Stiles-Shields, Montague, Lattie, Kwasny, and Mohr, (2017) aimed to identify barriers of both face-to-face delivery and smartphone app delivery of mental health intervention. They also used a novel card-sorting method in order to inform the design and delivery of such apps to result in smoother uptake. The study found that concerns over the efficacy of the intervention, app functioning, privacy, cost, lack of guidance and tailored feedback were the top concerns for smartphone delivery. However, as is common with mobile mental health research, this study did not include older adults, with participants having a mean age of 37. With previous literature suggesting the suitability of smartphones for mental health delivery, it seems pertinent to also understand the unique barriers that older adults face in the use of smartphones for mental health intervention delivery as studies suggest older adults have unique experiences of using smartphones for health due to the fact they are a different type of user in terms of knowledge, vision needs, dexterity, cognitive abilities and finances (Mohadisdudis & Ali, 2015). Consequently, the studies conducted within this thesis will focus on mobile mental health interventions that can be accessed through a smartphone.

Chapter 4: Behavioural Models in Technology Acceptance Research

As the benefit of technology has been widely acknowledged in a variety of research domains, a number of theoretical models have been applied to guide the acceptance of different technologies within the context of overall health, but also specifically in the context of MMHI acceptance. While many behavioural models may be applicable, such as Diffusion of Innovation Theory (DOI) and the theory of planned behaviour (Ajzen, 1991), they have not been extensively applied in the context of healthcare technology (Dünnebeil, Sunyaev, Blohm, Leimeister, & Krcmar, 2012). A recent review states that the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT) are the most widely used models applied to the acceptance of mobile health technology, with TAM being the most widely used (Garavand, Samadbeik, Kafashi, & Abhara, 2017). Despite differences, these models converge on the notion that an individual's beliefs and attitudes towards technology play an important role on usage behaviour (Paré, Sicotte, Le`, & Jacques, 2006). Due to concerns that technology acceptance research in healthcare are not based on theoretical foundations (Gammon, Johannessen, Sørensen, Wynn, & Whitten, 2008; Peek et al., 2014) the remainder of this chapter will describe the aforementioned theories and their similarities in the prediction of behavioural intention to use technology.

4.1 Diffusion of Innovation Theory

The Diffusion of Innovation (DOI) theory is pertinent to technology adoption. The DOI model aims to explain how the dissemination and adoption of innovative technologies develops over time as it communicated through social channels (Rogers, 2003). The model is made up on three components, adopter characteristics, characteristics of an innovation and the innovation decision process. The following sections will provide an overview of these components as described by Rogers, (2003).

Innovation Decision Process: This process describes how an individual goes from becoming aware of an innovation (knowledge) to forming an attitude toward it, to then deciding whether or not they will adopt or reject the innovation. This process consists of five stages: knowledge, persuasion, decision, implementation and confirmation. According to Rogers, (2003) the knowledge stage is where an individual becomes aware of the existence of a particular innovation and of how it functions. The persuasion stage is where the individual then forms an attitude toward the innovation, which is either favourable or unfavourable. At the decision stage, the individual decides whether or not they are going to accept or reject the innovation.

If the individual accepts the innovation, the implementation stage is when the individual puts the innovation to use and finally at the confirmation stage, the individual seeks reinforcement for the decision made. However, this decision may be reversed if exposed to conflicting information or messages about the innovation.

Characteristics of an Innovation: Rogers, (2003) proposes that the rate of adoption of an innovation is influence by five attributes: Relative advantages, compatibility, complexity, trialability and observability. Relative advantage refers to "*the degree to which an innovation is perceived as better than the idea it supersedes".* Compatibility refers to *"the degree to which an innovation is perceived to be with the existing values, past experiences and needs of potential adopters".* Complexity is *"the degree to which an innovation is difficult to understand and use".* Trialability is *"the degree to which an innovation will be experimented with on a limited basis"* and finally, Observability is *"the degree to which the results of an innovation are visible to others"*

Adopter Characteristics: The DOI model categorises adopters of technology into five categories: Innovators, early adopters, early majority, late majority and laggards. Innovators are the first group to adopt an innovation and have the ability to understand and apply complex technical knowledge. The next group to use the innovation are the early adopters who are also well connected with technologies and tend to be role models as other members come to early adopters for advice. Next are the early majority and late majority who make up approximately 68% of the population of the social system. Finally, the laggards are the most sceptical towards technology, and show the highest levels of resistance and therefore are the last group to adopt an innovation (Sahin, 2006; Zhang, Yu, Yan, & Spil, 2015).

A recent review of frameworks used to understand clinicians adoption of mobile health technologies found that the DOI was one of the most commonly used frameworks (Jacob, Sanchez-Vazquez, & Ivory, 2020). However, some researchers suggest that due to its focus on system characteristics and environmental aspects of adoption, it is less practical for prediction of technology acceptance outcomes compared to other models (Taherdoost, 2018) and therefore it was deemed an inappropriate fit for this thesis.

4.2 Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is a widely known, and widely used theoretical model. Stemming from the Theory of Reasoned Action (Fishbein & Ajzen, 1975) the TPB posits that

behavioural intention is the underlying basis for behaviour. Behavioural intention is determined by attitudes, perceived behavioural control and subjective norms. Within the model, attitudes refers to *the degree in which a person has favourable or unfavourable evaluation of the planned behaviour*, subjective norms describes the *perceived social pressure to perform or not perform the behaviour* and perceived behavioural control refers to *perceived ease or difficulty of performing the behaviour* (Ajzen, 1991; Westerhof, Maessen, De Bruijn, & Smets, 2008). Figure 2 provides a visual illustration of the theory.

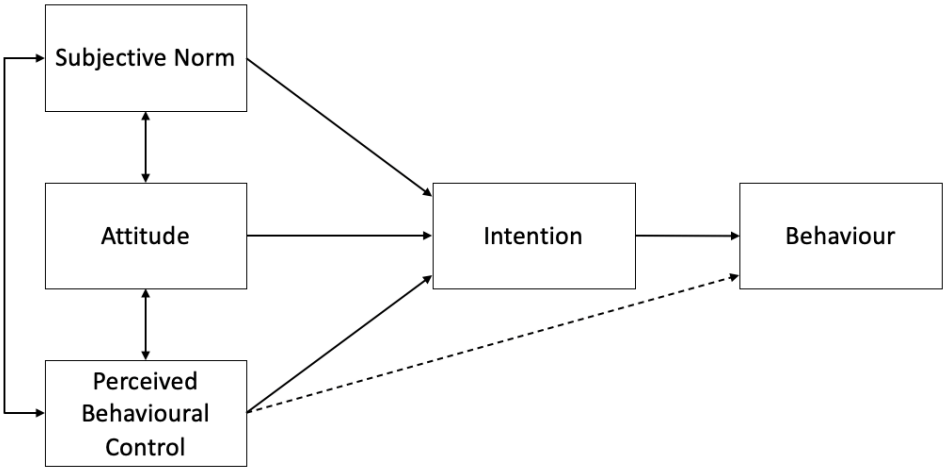


Figure 2: Theory of Planned Behaviour

This theory remains widely used and has been applied to a number of research contexts with prolific use in the disciplines of health and technology use. For example, the model has been applied to health behaviours such as, smoking cessation, weight loss, drug taking and promotion of safe sex (McEachan, Conner, Taylor, & Lawton, 2011). More specifically, Westerhof et al., (2008) apply the theory to investigate intentions to seek preventative psychological help in a sample of older adults in the Netherlands. The study shows that older adults have low intentions to seek psychological help, but their intentions to seek preventative help is more favourable than their intentions to seek therapeutic help.

Furthermore, in a meta-analysis of the TPB in predicting health-related behaviours, it was found that the TPB could account for 19.3% variance in actual behaviour and 44.3% variance in intention and it was therefore concluded that the TPB provides strong predictions of intention and behaviour across a range of health behaviours.

In the application of the theory to technology use, Cheon, Lee, Crooks, and Song, (2012) used structural equation modelling to investigate mobile learning readiness in higher education

through a sample of college students. The study found that 87.2% of intentions could be explained by the three factors in the model, and that each of the factors identified (attitudes, subjective norm, perceived behavioural control) all positively influenced intention to adopt mobile learning. It was therefore concluded that the model explained college student's acceptance of mobile learning well.

Furthermore, applications of the model include predicting use of social networking sites. Baker and White, (2010) adopted the model to predict adolescent use of social networking sites by disseminating a questionnaire to secondary school students. The authors measured the existing TPB components, while also including measures for self-esteem and group norm in an attempt to extend the theory. The results showed partial support for the TPB model with intentions to use social networking sites significantly predicted by attitudes and perceived behavioural control. However, self-esteem did not show as a significant predictor of behavioural intention.

Despite the TPB being useful to explain behaviours and has been applied to health behaviours and technology adoption, it is superseded by the more specific TAM which was specifically tailored for the acceptance of technologies (Wang, Rau, & Salvendy, 2011). Additionally, the TPB has received its fair share of criticism, with some questioning the validity and utility of the model and advocating for the retirement of the model (Sniehotta, Presseau, & Araújo-Soares, 2014).

Further criticism comes from Hardeman et al., (2002) who conducted a review into applications of the theory for behaviour change interventions. Out of 13 studies which included the theory of planned behaviour in the design of an intervention, only half found a change in intention to use. Hardeman and colleagues also comment on the fact that it is difficult to make conclusions about the true effectiveness of the model as authors rarely included details of which TPB components were targeted and often referred to other theories and models. As a result, they conclude that evidence of the effectiveness of the model in behaviour change is lacking.

4.3 Unified Theory of Acceptance and Use of Technology

The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003) was derived from a variety of behavioural models, including the TAM (discussed below), Theory of Reasoned Action and Diffusion of Innovation Theory. Like TPB, the UTAUT is based on the premise that actual use of technology is a result of behavioural intention. In this theory however, behavioural intention is predicted by four key variables:

performance expectancy, effort expectancy, social influence and facilitating conditions. Performance expectancy is the expectation of a user that the system will be useful for the job, which corresponds to the TAMs construct of Perceived Usefulness (Ammenwerth, 2019). Likewise, effort expectancy refers to the expectation that the system will be easy to use and free of effort, which refers to the TAM construct of perceived ease of use (Ammenwerth, 2019). The UTAUT model extends the TAM by including social influence and facilitating conditions, with the exclusion of attitudes. Social influence is defined as "*the degree to which a user perceives that important others believe he or she should use the new system".* While facilitating conditions are defined as *"the degree to which a user believes that an organisational and technical infrastructure exists to support system use"* (see Figure 3). Alongside the four key constructs, the model also includes four moderating variables: gender, age, experience and voluntariness of use which have been found increase the predictive validity of the model (Venkatesh et al., 2003).

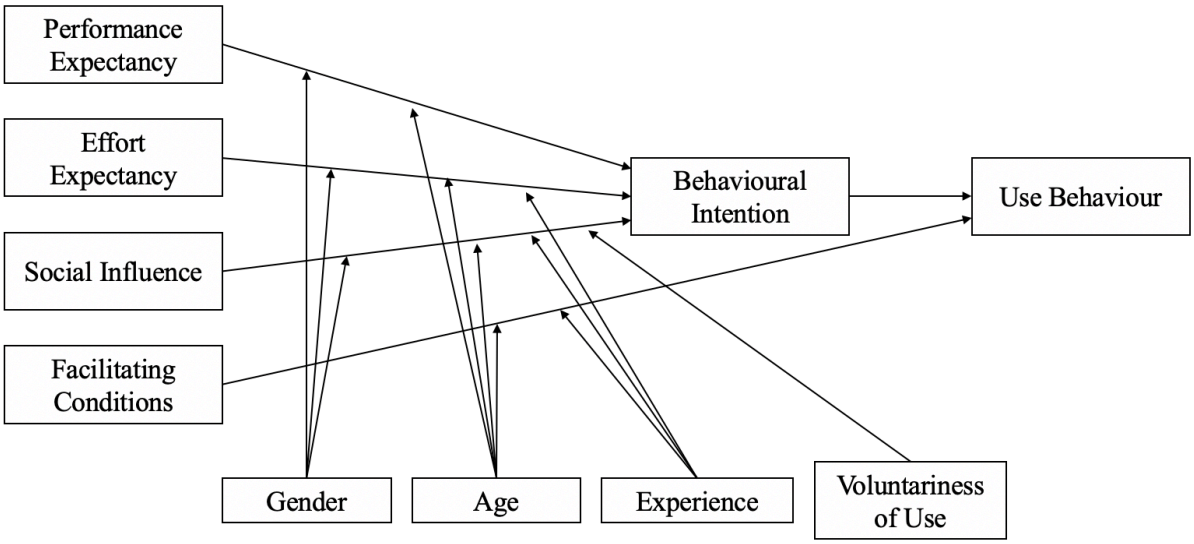


Figure 3: UTAUT Model

Similar to the TAM, the UTAUT theory is widely used within healthcare literature with a wide range of applications. Indeed, some researchers have successfully applied the UTAUT model to investigate the factors influencing adoption of mobile health technologies in the older adult population. Hoque and Sorwar, (2017) tested an extended UTAUT model which also included technology anxiety and resistance to change and found that the UTAUT model is applicable to adoption of mobile health technologies for the elderly, providing further support for the hypothesised relationships between the model's constructs.

Furthermore, after having identified that TAM and UTAUT have not been tested among older people, de Veer et al., (2015) conducted a study to explore determinants of intention to use electronic-health (e-health) in a sample of older adults aged 57-77. They found that while older adults were open-minded towards the use of e-health, perceived usefulness and perceived ease of use had been accounted for, there was no social influence showed additional value in explaining intention to use. This evidence questions the suitability of the UTAUT model in explaining intentions to use, as the TAM constructs of perceived usefulness and perceived ease of use were much more effective at influencing intentions to use technology for health in older adults.

As previously mentioned, the UTAUT model excludes attitudes which has resulted in some criticism of the model. Recently, attitudes have once again become a focus of technology acceptance literature, with researchers advocating for the role attitudes play in the acceptance of new technologies (Dwivedi, Rana, Jeyaraj, Clement, & Williams, 2019). Dwivedi et al, (2019) propose a revised UTAUT model which considers attitudes and found that the model performed better than the original UTAUT model, concluding attitudes is an integral part of the model.

Although the application of the UTAUT within research investigating the uptake of MMHIs is still rare, components of the model have been used in recent research (Apolinário-Hagen, et al., 2017). For example, Hennemann, Beutel, and Zwerenz, (2016) utilised the UTAUT theory to investigate the drivers and barriers to acceptance of web-based after-care and found that performance expectancy, effort expectancy and social influence were significant predictors of acceptance. However, there was no support for the role of facilitating conditions in the acceptance. The authors concluded that the UTAUT is a viable model to apply to the context of MMHIs, however they note that acceptance models should be extended and adapted to the context of different target groups. This model was tested in a population with a mean age of 45 years, and therefore it is unclear if this can be generalised to an older adult population.

Additionally, studies have used the UTAUT to guide 'acceptance facilitating interventions' which aim to provide information about MMHIs to improve acceptance (Apolinário-Hagen et al., 2018; Baumeister et al., 2014, 2020; Ebert et al., 2015) and to identify determinant factors of public acceptance of stress management apps (Apolinário-Hagen, Hennemann, Fritsche, Drüge, & Breil, 2019). However, as is the case with much research investigating uptake of

MMHIs, very little consideration is given to the older adult age group in the application of these models when investigating uptake of MMHIs.

4.4 Technology Acceptance Model

The TAM (Davis, 1986) is a widely used framework which provides insight into an individual's decision to use or adopt technology. The TAM proposes that technology acceptance (intention to use) is dependent on the user's attitude which in turn is determined by a user's perception of perceived usefulness and perceived ease of use (see Figure 4). Within the model, perceived usefulness is defined as "*the degree to which a person believes that using a particular system would enhance his or her job performance",* whilst perceived ease of use is defined as "*the extent to which the prospective user expects a target system to be free of effort"* (Davis, 1986). The TAM is grounded in existing theory as it stems from the Theory of Reasoned Action (Fishbein & Ajzen, 1975) and has been integral to the development of more recent theories such as UTAUT (Venkatesh et al., 2003).

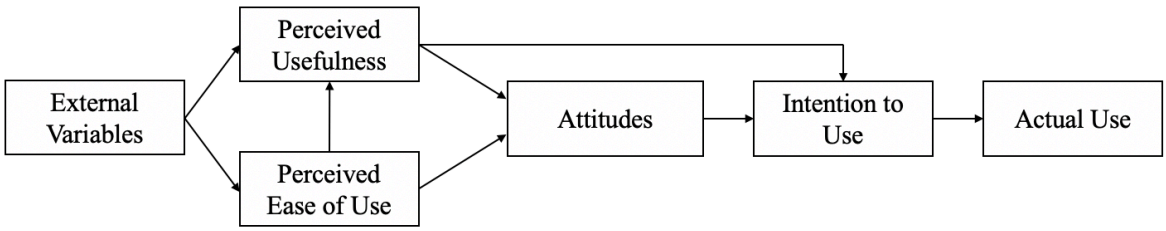


Figure 4: Technology Acceptance Model

Despite the fact that the TAM was developed in the context of technology acceptance in the workplace, a meta-analysis has shown that TAM is a robust and powerful predictive model (King & He, 2006) and as a result, the model has been increasingly applied to other research contexts and areas of research, including health and health technology adoption.

More recently, the TAM constructs have been shown to have strong support in the consumer-orientated health technologies domain, and support the specific relationships hypothesised in the original TAM model (Tao et al., 2020). Of particular importance, the meta-analysis by Tao et al., (2020) supports the role of attitude and the relationship between attitude and intention to use in the uptake of health technologies. Attitudes has been excluded from later versions of the TAM model (TAM2, UTAUT) and so the authors urge a re-consideration of the role of attitudes in the uptake of health technologies.

While TPB, UTAUT, and the TAM have similar concepts and are all centred around ones behavioural intention to use a particular technology, the TAM is deemed the most suitable to guide the development of this thesis. The TAM has been applied in ageing research, with studies applying the model to ageing in place, which refers to older adults continuing to live in the community with some level of independence, rather than in residential care (Wiles, Leibing, Guberman, Reeve, & Allen, 2012). Peek et al., (2014) conducted a systematic review of the factors for acceptance of technology for ageing in place. They found that the majority of studies did not have a theoretical foundation, but of the ones that did, the TAM and UTAUT were the models of choice due to their predictive power. An additional review has also found that the TAM is a popular model when investigating the uptake of telemedicine (the use of technology for health) (Gammon et al., 2008).

Despite the TAM being a robust model and widely applied to healthcare technology acceptance, the model has been scarcely applied to the specific context of acceptance of mental health technologies. One of the few studies in this regard proposes an extended TAM model for the acceptance of MMHIs for young adults in Germany (Becker, 2016). Along with the original TAM constructs, the proposed model by Becker, (2016) also includes social influence, perceived self-efficacy, trust and task-technology fit. However, this study was conducted in Germany among younger adults (18-35) and showed little rationale for the inclusion of such factors. Therefore, it is unclear whether the factors identified in the TAM are relevant and applicable to the acceptance of MMHIs within older adults in the UK.

A second example of the TAM being applied to mental health technologies comes from a study where the TAM was adopted to examine mental health professionals' and young adults' acceptance of MMHIs. Lazuras and Dokou, (2016) predicted 72.9% in usage intentions for mental health professionals and found that perceived usefulness was the most important predictor in their model, which supports existing TAM literature. Furthermore, they found that perceived ease of use was not a significant predictor of intentions for mental healthcare professionals, suggesting that ease of use is of lesser importance compared to perceived usefulness for mental health professionals.

While the model is often chosen in favour of other models (such as the UTAUT) due to the fact it is credited for being parsimonious (Shropshire, Warkentin, & Sharma, 2015) and easy to understand (King & He, 2006), the TAM was originally developed in the context of acceptance of technology in the workplace. Researchers have therefore encouraged the application of the

model to more specific healthcare contexts and to extend the model with additional factors that impact on technology acceptance to strengthen the model (Holden & Karsh, 2010; Tao et al., 2020). As a result, it was decided that the TAM is a suitable theoretical framework to guide the thesis as it has been extensively used in healthcare with a meta-analysis of TAM studies investigating e-health application acceptance among patients and the public it was concluded that TAM is an appropriate choice to study the adoption of e-health applications (Chauhan & Jaiswal, 2017).

4.5 Chapter Summary

This chapter discusses relevant theories that have been used in the adoption of technology in general, and health technologies, and proposes the TAM to be a suitable model to guide this thesis. The following chapter outlines the first study of this thesis, which aims to investigate the psychological barriers older adults currently experience in the uptake of MMHIs.

Chapter 5: Study 1: Barriers to Older Adults' Uptake of Mobile Mental Health Interventions (MMHIs)

5.1 Chapter Introduction

Chapter 2 and chapter 3 outlined how MMHIs represent an opportunity for the delivery of mental health intervention for older adults, yet this age group are underrepresented in existing literature investigating barriers to use MMHIs. In particular, barriers to the use of MMHIs among older adults who have few structural barriers, and already own and can use appropriate technologies remains unclear – as these older adults are the most likely users of such intervention. This study set out to investigate the barriers that older adult technology users experience in the uptake of MMHIs. The chapter begins by reviewing the literature specifically related to barriers to the adoption of MMHIs before describing the methods, results and discussion of the findings.

5.2 Background

Literature focusing on barriers for physical health interventions suggest that older adults experience physical/structural barriers when engaging with mobile-based interventions, such as access to/ownership of technology (Wykes & Brown, 2016). While these findings highlight the effects of the 'digital divide' in healthcare, the assumption of poor technology use among older adults as a structural barrier to uptake and engagement is challenged (Cangelosi & Sorrell, 2014). In Chapter 2, it was established that technology use among older adults is increasing substantially (Vaportzis, Clausen, & Gow, 2017), with increased feelings of confidence in technology and readiness to use technology for health purposes (LeRouge et al., 2014), and positive attitudes towards online interventions (Schneider et al., 2018). Coupled with the recent finding that there is no age based 'digital divide' for the effectiveness of mobile interventions (Schneider et al., 2018), it is not clear if assumed structural barriers are present. However, there are likely to be other factors preventing large-scale uptake of these interventions for older adults. Evaluating these barriers to uptake can inform strategies for increasing uptake of MMHIs in older adults (Schröder et al., 2015).

While older adults are underrepresented in literature surrounding mobile mental health interventions (Crabb et al., 2012), research has investigated barriers to uptake in younger age groups. For instance, lack of treatment-seeking behaviours is shown to predict negative attitudes towards mobile interventions (Apolinario-Hagen et al, 2018), data privacy and

confidentiality concerns influence perceptions of trust and acceptance (Ebert et al., 2015; Hollis et al., 2015; Huckvale, Prieto, Tilney, Benghozi, & Car, 2015), and low awareness of mobile interventions is a barrier to help-seeking in general (Gulliver, Griffiths, & Christensen, 2010). It is unclear if these psychological barriers apply to the rising number of older adults who are adopting new technologies. It may be that older adults engage with technology differently to other age demographics and may experience unique barriers (Hollis et al., 2015). Literature looking at barriers for MMHIs in older adults is scarce, however a recent qualitative study (Andrews et al., 2019) explored older adult's perspectives on using digital technology to maintain good mental health. Five barriers were identified, three of which are related to concerns over technology use or the usability of technology. For example, the perception that technology is inferior to humans, usability issues and a fear of consequences may affect engagement with technology. However, it is noted within this study that limited technology experience of the participants limit the findings.

Given that Knowles et al., (2015) highlight the importance of psychological barriers in younger age groups, the current study was specifically interested in the psychological barriers that older adults may encounter in the uptake of digital interventions rather than structural barriers such as technology ownership, by including participants who regularly use technology to account for this limitation (Andrews et al., 2019).

The research question was "what are the barriers that older adults with access to technology face in the uptake of mobile-based mental health interventions?"

5.3 Method

5.3.1 Participants

Participants were recruited from four volunteer groups in the North East of England that are attended by older adults. Inclusion criteria were: i) retired; ii) English as their first language; iii) aged > 50 years, in line with the Mental Health Foundation's (2018) definition of later life; iv) some understanding or use of technology; and v) had experienced a period of low mood within the last six weeks. Ten participants between the ages of 53 and 77 (mean = 68, SD = 7.76, seven female) were recruited, an adequate sample size for thematic analysis (Braun & Clarke, 2013). Nine out of 10 participants had obtained a Foundation Degree or higher and owned a smartphone with the ability to download apps. Table 1 provides an overview of participants' demographic profile.

Table 1: Participants' Demographic Profile

Participant code	Age	Education (highest award)	Pre-retirement career	Ownership of smartphone capable of downloading apps
PT001	77	Bachelor's degree	Project Manager	Yes
PT002	76	H.N.C	Army Air Corps	Yes
PT003	69	Bachelor's degree	Probation Officer	Yes
PT004	68	Bachelor's degree	Primary School Teacher	Yes
PT005	77	Bachelor's degree	Bookshop Assistant	Yes
PT006	53	Post-graduate degree	Access and Inclusion Consultant	No
PT007	71	Bachelor's degree	P.E Teacher	Yes
PT008	64	Bachelor's degree	Paediatric Dietician	Yes
PT009	67	Foundation degree	Senior Children's Worker	Yes
PT010	60	GCSE	Secretary	Yes

5.3.2 Procedure

The study was approved by Northumbria University Research Ethics Committee. Interviews took place on the university campus. The interview schedule was devised in line with study aims (Appendix 1). Informed consent was given by all participants, after which they completed a demographic questionnaire.

After the first set of questions from the interview schedule were asked, participants were shown examples of current NHS apps from the NHS apps library (Table 2) accompanied by an explanation of their features. Further questions then followed the demonstration of the apps to explore participants' thoughts and opinions of each app. This was guided by the interview schedule (Appendix 1). This demonstration facilitated conversation about MMHIs and ensured participants understood what MMHIs are.

Interviews were audio-recorded and lasted between sixty and eighty minutes. A MacBook Pro laptop displayed the NHS apps store and a smartphone with some example apps pre-downloaded was used to demonstrate to participants some of the available apps on the NHS apps library for mental health.

Following completion of the study, participants were fully debriefed and given a £10 Amazon voucher as a thank you for their time. Audio recordings were transcribed verbatim by a professional service and then checked for accuracy.

Table 2: Description of Applications Demonstrated to Participants

Application Demonstrated to Participants	Description of Features
Ieso	This app provides instant messaging with a trained therapist trained in Cognitive Behavioural Therapy (CBT). Communication is through text so the sessions can be reviewed at any time by the user.
My Possible Self	This self-help app delivers intervention through a number of learning modules to tackle unhelpful thinking (for example, 'Building Happiness and Wellbeing'). It also provides mood tracking and mood history and is based on CBT, problem solving therapy, interpersonal therapy and positive psychology.
Catch It	Catch It is a self-help mood diary that uses CBT principles to encourage users to record and rate their mood, reflect on what the user is thinking and then prompts the user to think of a better way of dealing with the problem.

5.3.3 Analytical Strategy

Thematic Analysis was chosen to analyse the data using NVivo 11 (Braun and Clarke, 2006). This process was data-driven and conducted inductively. Thematic analysis is a suitable method of qualitative analysis as it is a theoretically flexible approach which allows flexibility of epistemological and ontological position (Braun & Clarke, 2006). As such, a contextualist approach was identified as a suitable theoretical position for this thematic analysis. Contextualism is an epistemological position that sits between positivism and constructionism and explores experiences, meanings and the reality of participants (Braun & Clarke, 2006).

Following transcription, transcripts were imported into NVivo 11 software which was used throughout the analysis process. In line with Braun and Clarke's (2006) six steps of Thematic Analysis, the transcripts were read several times and initial codes were noted. Transcripts were then coded to identify features that were pertinent to the research question. All codes relevant

to the research aims were considered to devise themes. Thematic maps were utilised in order to visualise and refine themes. Once themes were identified, they were defined and named. Finally, illustrative quotes were selected for each theme.

5.3.4 Analysis

As barriers can be encountered at both the individual level (such as psychological factors), and the macro level (such as law and policy), this study utilised the Social Ecological Model (SEM) as a framework to contextualise identified barriers and delineate each barrier's role within the wider society and environment (Stokols, 1996). The SEM comprises five levels: individual, which focuses on intrapersonal factors such as knowledge, attitudes, behaviour, awareness, self-concept and skills; interpersonal, involving social support, including family, friends and health care providers (Salihu, Wilson, King, Marty, & Whiteman, 2015); institution, shaped by the healthcare providers rules, regulations and general attitudes towards research; community, concerning convenience and acceptance of an intervention, but also the relationship between organisations, charities and information groups within a defined area; and the public policy level regards the local, state and national laws and policies (McLeroy, Bibeau, Steckler, & Glanz, 1988; Salihu et al., 2015).

Identifying barriers at the different levels of a user's social ecology provides an insight into the factors that currently pose the most barriers. This allowed identified themes to be organised from the micro, individual level, to the macro, organisational level.

Six themes were identified: Mental e-Health Awareness, Privacy/Confidentiality, Seeing Facilitates Therapeutic Alliance, Incongruent Role of the GP, Discontinuation, and Interaction with Technology. These themes were mapped onto the SEM model based on the description of each level (Figure 5).

Figure 5: A Social-Ecological Model of the Barriers to Uptake of MMHIs for Older Adults.

5.4 Results

5.4.1 Individual Level

5.4.1.1 Mental e-Health Awareness

Within the individual level, mental e-Health awareness was the most common barrier throughout this study. This theme explores participant's lack of understanding or awareness of MMHIs, and how this may translate into potential barriers. This theme is comprised of two sub-themes: knowledge, and trust.

5.4.1.1.1 Knowledge

'Knowledge' was a commonly mentioned barrier in the dataset as all of the participants described having no knowledge of MMHIs, or the NHS digital apps library, prior to the interview:

> P3: *"I'm really interested in the fact that the NHS website has apps, which I had no idea about. But then I've never looked so I wouldn't know."*

> P5: "*I knew nothing. I have never looked to see what anything said online about depression, which I suppose is rather strange, really. Because if I hear of somebody with an illness, I will often look up their illness to see what it is."*

Participants suggested that the demonstration of NHS-endorsed apps had increased their understanding of mobile-based interventions:

> *P1: "yes, I, you've opened my mind to the fact that there is quite a lot out there which I was completely unaware of. And maybe I'm going to investigate ones where you don't need the GP to refer you to, just to have a look. You've stimulated my interest in that."*

One participant suggested that the interview itself made them more willing to consider using in the future:

> *P4: "erm it's made me more aware of what's out there. I've never delved into it so I've never known what was there. So now I'm more interested if the need occurs, to use one. mmhmm definitely"*

The data suggests that participants had positive attitudes towards MMHI after the demonstration of apps increased their knowledge, as participants were not aware of MMHIs before participation in this interview.

5.4.1.1.2 Trust

The sub-theme of trust at the individual level explores two prominent points; trust in the intervention and a lack of trust in mobile apps in general. Firstly, participants presented a distrust of mobile-based interventions. For example, one participant felt as though they would not have faith in a digital intervention as they were not certain where it was getting its information from:

> P2: *"I would use it – yeah. I wouldn't have much faith in it though…*
>
> *Because I would be unsure of where this got the recommendations from. I'm feeding information into that and its making a decision and then it's giving me a result. Where does it get its information from to make that decision?"*

Furthermore, as well as mistrust in the intervention itself, mistrust was also displayed due to the fact that older adults were not able to identify 'who' they are engaging with:

> Interviewer: *"I think I heard you say a couple of minutes ago that you wouldn't trust it?"*

> P3: *"No I wouldn't, because it, it's a voice on a screen. It's like watching the television or going to the cinema – where does it come from? Who is it? How do they walk? What do they look like? No, I wouldn't have faith in anything like that"*

This sentiment was also reflected in the context of discussing an existing app that provides an instant messaging chat with a trained therapist:

> P7: "*No. I don't think that would be for me at all."*
>
> Interviewer: "*Okay. Why not?"*
>
> P7: "*I just don't like the idea of not knowing who I'm talking to"*

Furthermore, distrust shaped negative attitudes towards apps among older adults. Despite access to a smartphone, the data suggests a negative attitude towards the use of apps. Some reported not using apps due to simply having no interest in them in general, whereas others state that they would not download an app to benefit their mental health, unless it came with clear credentials:

> Interviewer: *"Would you download something if it had a benefit on your mental health?"*
>
> P1: *"yes, if it came with the right credentials, I would've had to have heard about it from erh, I wouldn't see – well anyway I don't browse the app store, but if I saw 'mental health' or however you jazz it up, I wouldn't download it"*

The same participant went on to say:

> P1: "*but if journalists had talked about it on BBC breakfast saying 'hey there's a new app that makes you aware of, and how to handle your moods' well then I may be interested, it would spark my interest. I would then look into it."*

This demonstrates how older adults require 'credentials' that reflects the authenticity of a trusted source. It also suggests that older adults require signposting from other trusted media in order for them to seek out apps and be interested in using them. This indicates that a general

lack of trusted facilitators that are willing to recommend these apps to older adults, thereby facilitating its uptake.

5.4.1.2 Interaction with Technology

Older adults showed concerns over how the technology could present a barrier in multiple ways. Firstly, participants in this study had concerns over the technological skills required to effectively navigate and engage with the interventions:

> P5: *"It demands quite an ability to manage, you know, getting backwards and forwards and filling things in. So it does demand quite a lot of technological ability. I would find it quite difficult to answer some of the questions."*

Secondly, technology as a medium to deliver a mental health intervention may be a barrier to effective engagement as older adults may not be able to express themselves as clearly through technology:

> P5: "*Again, I think the negative side is that half of the elderly population wouldn't be able to cope with the technology and many would not be able to express themselves very well."*

Although this is a barrier, further investigation is required to investigate the true nature of this. It may be that older adults are not able to interpret their own thoughts coherently enough to be able to convey them through technology which may suggest a 'mental health literacy' or educational barrier rather than a technical inability. On the other hand, the issue may be technological, and the participant was expressing an inability to express thoughts through technology as a medium.

Finally, one participant felt that if technology didn't work properly it would actually add to the stress and therefore technical issues could interfere with clinical efficacy:

> P8: *"The fact that its technology and not everybody- like me. You know, if it doesn't work, I'm just going to- it doesn't work. I'm too stressed. It could add to the stress. It would add to my stress if I started doing it and it froze and I couldn't work it. That would just be stressful for me. So it may add to their stress."*

5.4.1.2.1 Computer Self-Efficacy

This sub-theme represents perceived ability to accomplish tasks using a computer, previously found to be an important contributor for uptake of digital CBT for chronic pain (Schneider & Hadjistavropoulos, 2014). Concerns arose around participant's perceived ability within themselves to be able to use the intervention correctly:

> P2: *"I don't know whether I would put the correct information in, to get the correct information out"*
>
> P6: *"I don't trust myself to know how to use it"*

This suggests that some older adults have doubts over how they may engage with a digital intervention for mental health caused by concerns over their own ability to use it. Much like perceived effort and intrinsic motivation, computer self-efficacy is also a major determinant of perceived ease of use in Technology Acceptance Model (TAM) (Viswanath Venkatesh, 2000). Of note, P2's comment showing concern over whether they are *"putting the correct information in to get the correct information out"* provides an example of how a user's technical ability could impact on the clinical effectiveness of an intervention. If an older user has doubts over the information they are providing they may choose not to disclose things over concerns it's not correct, or not relevant. This is specifically important for those older adults who have a poorer understanding of mental health –particularly depression (Farrer, Leach, Griffiths, Christensen, & Jorm, 2008).

5.4.1.3 Discontinuation

This theme explores factors identified by participants that would cause older adults to cease engagement. Although these are not direct barriers to uptake, they pose as barriers to sustained use with an intervention which is equally important when interventions often require users to complete the entire content of the intervention (Karyotaki et al., 2017). There are two main sub-themes that were found within the data: unrealistic outcome expectation and perceived effort.

5.4.1.3.1 Outcome Expectation

Outcome expectation refers to the therapeutic outcomes that participants expect from an intervention. In particular, participants felt that if they were not making enough progress while using the intervention, they would stop using it:

> P5: *"I suppose if you felt you weren't getting anywhere that what they suggested was inappropriate or something you couldn't do, or if you felt it was all going around in circles and not getting anywhere, you might be inclined to give up on it"*

Another participant had similar views, but also suggested that they would stop using an MMHI if they were unable to gain a better understanding or education of their symptoms and how it might affect them:

> P3: *"If I felt I wasn't going anywhere, if I felt it was just a talking shop with no sort of, that it wasn't doing anything for me [...] or getting, or gaining understanding, or getting support that I need at any one particular time."*

Ensuring that older adults have realistic expectations of an intervention, and the intervention being able to deliver results is important for older users to stop them seeing digital mental health interventions as '*a waste of time':*

> P3: *"I wouldn't plough on using something if I wasn't getting something out of it – no it would be a waste of time."*

While it appears that older adults want to be able to feel as though they are 'getting something out of it' and are making progress, it is important to manage these expectations so that results are not expected straight away. This is important in promoting adherence to mobile-based interventions and preventing discontinuation as number of sessions completed correlates with outcomes (Donkin et al., 2011).

5.4.1.3.2 Perceived Effort

Participants' concerns over perceived effort are covered in respect to two aspects: time concerns and intrinsic motivation concerns. Firstly, participants view towards perceived effort was reflected in their perception of how much time they thought would need to be invested into the intervention in order for meaningful engagement. There was a general consensus among the participants that they wouldn't have the time to engage with it:

> P10: "*I don't think so. I suppose sometimes people might think, "That's not for me," sort of thing, or, "haven't got time to do it," even though you've got 24 hours a day to do it, you know?"*

Furthermore, participants also had concerns over the effort required to engage in a digital intervention for mental health reporting that they may be '*too lazy'* or *'can't be bothered'* to engage:

> P6: *"I don't think I could be bothered to do all of that. Perhaps it's that I'm too lazy to do all of that, perhaps would be the more correct way of saying it"*

This may suggest that older adults do not place much value or see little gain from using them and therefore may not see them as a worthy time investment, which is counter-intuitive given that mobile interventions have been designed to save time and make access to treatment more efficient. In terms of discontinuation, if an older adult is using an intervention but feels the time investment is too large, they may decide not to continue its use.

5.4.2 Interpersonal Level

5.4.2.1 'Seeing' Facilitates Therapeutic Alliance

This theme refers to how participants saw a number of disadvantages to mental health interventions being delivered through technology rather than the traditional face-to-face method. Generally, older adults within the sample showed preference for face-to-face interaction with regard to mental health care. This theme consisted of the following two sub-themes which will be explored below: 'Therapeutic Disadvantages', and 'Seeing the Therapist Mitigates Concerns of Trust'.

5.4.2.1.1 Therapeutic Disadvantages

There were varying degrees of experience with mental health services, as some participants had experienced face-to-face therapy or counselling in the past, and some had not. Therefore, it is possible that participants with experience of mental health care provided different insights or expectations of what a digital mental health intervention may be able to accomplish compared to those who had not. Nevertheless, among participants there was a preference for face-to-face interaction over the use of digital technology.

This sub-theme explores how participants felt as though a digital intervention may provide inferior mental health care due to a perceived absence of interpersonal communication. For example, one participant felt as though a digital intervention would be harder to engage with if the symptoms of depression were bad enough, whereas in face-to-face care the therapist would be able to provide encouragement:

> *P5: "Also, again, if you were feeling bad enough, an unwillingness to engage with it that with a person face-to-face, they would encourage you to speak out and be able to say things because they can see you and they can see your tone of voice, or hear your tone of voice. Some people might find that easier than dealing with something on a computer."*

When discussing the negative aspects to mobile-based interventions, one participant felt that the absence of face-to-face communication in a digital intervention outweighed the *'trouble'* of travelling to a traditional face-to-face therapy session as the therapeutic experience would be more '*genuine*':

> P6: *"I would much rather go to the trouble of travelling to a therapy session, seeing somebody and talking to somebody face-to-face, rather than filling out a self-help manual […] because you're more likely to get a… I feel, perhaps wrongly, you're more likely to get a genuine answer or a genuine, not necessarily answer but, hearing"*

Furthermore, a participant who had experienced face-to-face therapy felt that delivering an intervention through technology detracted from the therapeutic process. The participant suggested that non-verbal cues were unable to be picked up on which may have provided the therapist with insight into the issue at hand:

> *P8: "They pick up- for example, the therapist I had was just so clever. Even though I was speaking she would say things to me about the way my body was, my attitude, my posture, my expression that I wasn't aware of. Then she'd make me think again. She would help me delve deeper into the problem so that I would have a better understanding of it.*

> *Whereas if you were just doing... there wouldn't be that. So you might get superficial help but there wouldn't be that- I know it's a very, very emotional experience, counselling, but if it's going to help solve internal problems, then I think a good counsellor is invaluable as a face-to-face... that's helpful"*

5.4.2.1.2 Seeing the Therapist Mitigates Concerns of Trust

Given participant's concerns over trust with MMHIs, the data also displays how face-to-face treatments facilitate trust. When confiding in someone to discuss sensitive issues such as

mental health, participants felt that without the personal engagement it was difficult to decide whether they would trust the person they're engaging with:

> P7: "*I think that, if I'm going to confide in somebody about how I'm feeling mentally or emotionally, I've got to feel that I can have eye contact with the person, and I've got to get a sensation of trust; that, if I saw a person and I didn't take to them, I wouldn't tell them anything. Whereas if I thought they were okay and a really nice person, then I would open up a lot more."*

Furthermore, within the context of an instant messaging service with a trained therapist, participants felt as though they would not be able to achieve the same level of trust between themselves and a therapist and that it was really something they could only judge through face-to-face contact:

> *P7: "I think I've got to have a face-to-face feeling about a person, because you're typing stuff in and they're typing stuff back, you haven't got a clue who they are; you haven't even got a clue if it's a man or a woman, or anything. So I think I'm still old fashioned enough to want the personal contact."*
>
> *P2: "I would rather look somebody in the face, see their expression, and hear the change in their voice. It's too far in the future for me that, stuff like that"*

5.4.3 Institutional Level

5.4.3.1 Incongruent Role of the General Practitioner (GP)

Participants in this study had conflicting views towards their GPs role in the treatment of mental health issues. Participants report seeing their GP as the 'first port of call' if they were to have a mental health issue and required help:

> P9: *"I think GPs are very pressed for time and depending on - although I think you can probably book two appointments together if you knew that you wanted to talk for a lengthier time - I think that would be a first port of call really, to be able to talk face-to-face to somebody"*

However, despite this, many participants had somewhat negative attitudes towards their GP and their ability to help with a mental health related issue:

> P1: *"I don't know, if you go to see your GP and you're, y'know, I don't think it's going to often work. Because they have 10 minutes, they haven't read your file. If you're lucky they'll read it in two minutes that you're there. Erm they have to be pretty skilled to be able to do very much. But I'm not sure that would work too well – with one visit anyway. Say come back in three months is not going to help"*

In particular, participants were concerned about the lack of time GPs were able to provide in appointments which created concerns surrounding the GPs ability to help with a mental health-related issue:

> P5: *"They really don't have time, the GP. They know, if they read it all, my background, but that's about it. They would be interested to know what I thought had caused this particular downturn, but that's about it. They don't give advice."*

5.4.4 Macro Level

5.4.4.1 Privacy and Confidentiality

Throughout the interviews, participants described concerns regarding the privacy and confidentiality of both their information but also their 'self' and the need for anonymity when engaging with digital mental health disorders. This theme will first explore concerns surrounding privacy of information and then privacy of the 'self'.

5.4.4.1.1 Privacy of Information

This sub-theme was a very prominent barrier across the data. Participants showed great concern over who had access to their data and information once it had been submitted to the intervention, and who was accessing it. Participants also demonstrated an understanding of cybersecurity insofar as websites can be hacked and information is not guaranteed safety if it is digitised:

> P3: *"Erm, I suppose this issue about confidentiality. Websites being hacked, people's personal details being hacked, y'know it's nothing, nothing is safe. Nothing is secure – and I know that, nothing on the web is 100% safe, it can't be. You'll always have people wanting to break systems because that's the nature of people. So I think that would be my main concern"*

This becomes particularly pertinent when the information is related to mental health. Older adults perceive mental health information as sensitive and would be worried about sending that information through technology if they were unsure of who was accessing it:

> P6: *"Also, I don't trust the… If I'm sending an email to somebody about something, then I don't know who else can see it. Anybody else in the world can see it […] If I was sending anything about my mental health issues, that's when I would begin to be really worried. That's what would stop me from sending anything about mental health."*

5.4.4.1.2 Privacy of 'The Self' (anonymity)

While some participants had very negative views towards sharing mental health information using technology, for others, concerns of sharing information regarding mental health were mitigated through anonymity of their identity:

> *P8: "I would rather be anonymous, to be honest. I realise I can't be because of the way these things work. They have to have funding and they have to be accountable and things. If I was anonymous I would have been more inclined to access it. I still am a bit dubious about going in as 'me.'"*

These concerns are a barrier to older adults engaging due to the fact that stigma is a well cited barrier to older adults not seeking help for mental health issues (Pocklington, 2017). However, digital mental health interventions have huge potential to mitigate the concern of stigma if they can be accessed anonymously (Schröder et al., 2015).

While the absence of privacy of one's identity could serve as a barrier for older adults, one participant also described how anonymity was important to ensure that MMHIs were accessible to people who are lacking in confidence:

> P10: *"I think in a way it could probably be quite anonymous if you could set up a username that it doesn't give personal details, or you might just have your- I suppose you could tailor it […] because I think it's a big step to go to something if you're lacking in confidence anyway."*

5.5 Discussion

In line with the research question, these findings provide an insight into the barriers that are preventing scalable uptake of MMHI for older adults. Thematic analysis identified six main themes when investigating the barriers to implementation for older adults that can be applied to the five different levels of the SEM. The themes identified were: mental e-health awareness, interaction with technology, discontinuation, 'seeing' facilitates therapeutic alliance, incongruent role of the general practitioner and finally, privacy and confidentiality. Interestingly, the majority of the themes identified within this study fell into the individual level of the SEM, suggesting intrapersonal factors pose the largest barriers to large-scale uptake for older adults.

Awareness of the existence of mental health interventions and their benefits is currently a significant barrier as none of the participants in this study described having prior knowledge of digital mental health interventions, despite self-identifying as 'technology users'. This is a common finding throughout existing research not only in relation to older adults or specifically for depression interventions but for the uptake of mobile-based interventions across age groups (Apolinário-Hagen et al., 2018; Gratzer & Khalid-Khan, 2016; Gratzer, Khalid-Khan, & Khalid-Khan, 2015; Lee & Coughlin, 2015). Knowledge can also be a significant factor when forming attitudes towards MMHI (Apolinário-Hagen et al., 2018) and predicting acceptance (Vis et al., 2018). This barrier is arguably the most important as the other concerns presented become irrelevant if older adults are not aware of the availability of mobile-based interventions for mental health in the first place.

Furthermore, while computer literacy and technological skills are not a new barrier to older adult's engagement with digital mental health interventions, it remains an important factor in ensuring continued engagement. For example, previous RCTs suggest older adults are likely to have technical challenges accessing or engaging with digital CBT, as well as a need for more guidance and precise instructions (Crabb et al., 2012). Notably, Rozental et al., (2015) found that difficulty interacting with the interventions interface and other technical problems can elicit negative psychological effects.

Emerging literature suggests that MMHIs are effective in the reduction of symptoms for older adults (Hobbs et al., 2018; Staples, Fogliati, Dear, Nielssen, & Titov, 2016; Zou et al., 2012), yet it seems there is a perception among older adults that by delivering the intervention through technology, it is detracting from the therapeutic process.

Similarly, the incongruence of the GPs role could pose barriers for increased uptake. Given that one of MMHIs roles is to take pressure away from GPs, it may not be feasible to rely on them to increase uptake in older adults.

The barriers identified may bring into question the suitability of some types of mobile-based interventions for the older age demographic, specifically self-help or unguided interventions. While studies have found them to be effective in reducing symptoms of depression in older adults, with automated prompts (Titov et al., 2016), the current study suggests that the type of barriers older adults are experiencing may reduce the potential of self-guided treatments in England. Spek et al., (2007) suggest that self-help is much easier to end or postpone treatment and places little responsibility on the user. As the results from this study suggest that older users may have little intrinsic motivation to continue using or complete an intervention for mental health it is likely that older adults have a high propensity to drop out. However, Spek et al., (2007) also suggest that telephone calls from a clinician provide support leading to increased completion rates. Hence, behavioural prompts or nudges may be required for older users to maintain high motivation and ensure continued use of an intervention.

Literature in this area has consistently found concerns with privacy and confidentiality of information to be a potential barrier for all age groups. For example, privacy concerns have been identified as a reason for discontinuation of an intervention utilising a sample of students (Doherty, Coyle, & Sharry, 2012). Furthermore, Torous et al., (2018) found that a concerning number of mental health apps don't have privacy policies available for users, and posits that users with low levels of health literacy are likely to misinterpret app privacy policies – particularly concerning for the older adult demographic who have lower health literacy than other age demographics (Manafò & Wong, 2012). There is currently insufficient privacy protection around personal health information and there is a lack of knowledge and expertise around cybersecurity in online mental health care (Wozney et al., 2017). This finding has been supported by interviews with therapists, who raised concerns over data protection and data security (Waller & Gilbody, 2009). Research also shows older adults are very cautious when it comes to sharing health information in social networks using technology – particularly information specifically relating to mental health as they classify mental health information as sensitive (McNeill, Briggs, Pywell, & Coventry, 2017). The current study supports this finding and therefore, failure to consider privacy concerns can cripple the scalability of uptake in older adults.

Across all levels of the social ecology, trust was a significant factor in a number of the constructed themes within this study. Trust is highlighted as a significant barrier to the uptake of MMHIs for younger adults (Gulliver et al., 2010; Torous et al., 2018), and so this suggests that trust is a pervasive sentiment cutting across age groups in relation to intervention uptake. The importance of trust was highlighted at an individual level as the users trust towards the intervention or the app was identified as an important issue. But also, at a more institutional level, trust was important in regards of who actually recommends the app. Participants suggested their GP and the NHS were trusted sources and also require some kind of recommendation from these trusted sources to facilitate use. This resonates with the concept of Trust Transference Theory which, although was developed in the context of consumerism, suggests that trust between a known entity can be transferred to an unknown entity (Lien, Wu, Chen, & Wang, 2014). The application of trust transfer theory within the healthcare setting is scarce, however, the analysis of the current study suggest that older adults may feel anxious about using a digital intervention for mental health without a recommendation and suggests that endorsement from the NHS or being on the NHS website may not be enough to mitigate these concerns for some participants.

Finally, while a number of barriers were identified, however none of the themes fit into the community level of the SEM framework. It is likely that community level barriers are currently experienced by older adults in the uptake of MMHIs. However as stigma still has a prevalent effect on older adults in terms of help seeking and disclosure of mental health conditions (Pocklington, 2017), it is likely that lack of older adults' conversation around mental health in general means that there is lack of opportunity to share information about mental health in a general sense, but also as information sharing about mood related apps. Furthermore, given the definition of the community level (McLeroy et al., 1988), it is unlikely that the participants in this study have an understanding of the relationship between organisations and charities within their area, meaning community level barriers were not explored in the current data set.

5.5.1 Limitations

This study was among the first within the research area to qualitatively investigate MMHIs for depression among older adults. The qualitative approach utilised within this study provide rich insights into uptake barriers for older adults and by consulting potential users of mobile interventions for mental health, provides a strong base in which to develop further insight into uptake of MMHIs. However, qualitative methods are inherently subjective and due to time

restrictions, the sample size was limited. While this is a limitation of all qualitative research, a sample of size of ten participants for thematic analysis is considered adequate for thematic analysis (Braun & Clarke, 2013).

This study investigated potential barriers to uptake of mobile mental health interventions for people who already use technology, as they are potential users of such an intervention. Furthermore, the participants had not undertaken a course of digital CBT or any type of self-help intervention. Therefore, opinions presented are based on participant's initial perceptions following a demonstration of a select few different mobile-based interventions available on the NHS website. While this means that evidence is not based on personal experience of a digital intervention, it was necessary to recruit from a non-clinical sample to investigate the potential of mobile-based interventions within a general sample of older adults who are potential users of the NHS apps library along with self-help interventions. As a result, insight was gained into the awareness of mental health interventions among this sample. Nevertheless, it may well be that had participants who had no understanding of technology been included in the sample, different barriers may have been found within the data.

Furthermore, it may be noted that there is a lack of extensive focus on the facilitators of uptake of MMHIs for older adults. Factors that facilitate the uptake of MMHIs play an important role in increasing their use, however the data in this study identified very limited facilitators for older adults. Participants identified that MMHIs are more accessible with regards to the fact that they are immediately available and elicit greater control, however this finding was far outweighed by the barriers presented in this chapter.

While limited conclusions can be decisively drawn, this study contributes vital information to an under-represented area of research and welcomes future work to build upon the findings discussed by conducting a large-scale analysis to explore the extent these perceived barriers may influence attitudes or willingness to use a MMHI.

5.6 Conclusion

This study aimed to identify barriers that older adults may face in the uptake of MMHIs. Through thematic analysis, six barriers have been identified in this study: Mental e-health awareness, Seeing Facilitates therapeutic Alliance, Privacy and Confidentiality, Incongruent role of GP, Discontinuation, and Interaction with technology. Through the six themes identified, this study has made a meaningful contribution to literature in that it was the first to

consider barriers to technologies specifically for mental health intervention within a purposeful sample of older adults. Furthermore, this study is the first in this area to gather qualitative data following a demonstration of MMHIs to older adults using a smartphone to improve the validity of the qualitative data. Despite the noted limitations, this chapter provides insight into important factors associated with uptake of MMHIs for older adults and provides precedent to a study which investigates whether these factors remain significant across a wider sample of UK based older adults and whether these factors are associated with attitudes towards MMHIs.

Chapter 6: Study 2: Determinants of Older Adults' Attitudes towards Mobile-Based Mental Health Interventions

6.1 Chapter Introduction

The previous chapter sought to understand the barriers that older adults who use technology experience in the uptake of mobile mental health interventions. Six key themes were identified ranging from the individual level of the Social Ecological Model to the Organisational level. However, as attitudes have been identified as a key determinant of use for MMHIs, and with a recent focus on the role that attitudes play in the uptake of MMHIs in other age groups, this study seeks to build upon the foundations of the previous study, and extant literature, by first quantitatively investigating older adult's attitudes towards MMHIs. Secondly, this study seeks to identify associations between the barriers presented in the previous chapter, other factors identified in existing literature and older adult's attitudes towards MMHIs, using an objective measure of attitudes towards MMHIs.

6.2 Background

The aim of research within the scope of the problem focused upon within this thesis, has been to increase the uptake of MMHIs. Towards achieving this aim, researchers have focused on 'acceptance', which has been measured in a variety of ways. In some studies, researchers have used a positive indication of intention to use as acceptance, while others have measured attitudes and other variables as a proxy for acceptance.

Attitudes have long been considered in behaviour change research and play a large role in the uptake of new technologies and play a prevalent role in technology acceptance theory. The Theory of Planned Behaviour (TPB) (Ajzen, 1991) describes how behavioural performance can be predicted by a behavioural intention which, in turn, are determined by attitudes, among other factors. The technology acceptance model (TAM) (discussed in Chapter 4) also suggests attitudes play a significant role in predicting acceptance of an intervention (Davis, Bagozzi, Bagozzi, & Warshaw, 1989). Researchers have examined the role of attitudes in the uptake of mobile mental health interventions and there is a large consensus that positive attitudes are an important precondition for the adoption of e-mental health services (Apolinário-Hagen et al., 2018; Apolinário-Hagen et al., 2019).

Recent research has identified the importance of developing methods to increase awareness and knowledge about MMHIs, in particular their efficacy, as existing knowledge and awareness is positively associated with positive attitudes and intention to use (Apolinário-Hagen et al., 2018; March et al., 2018). Despite the importance of attitudes in the uptake of technologies in a generic sense, relatively little is known about attitudes specifically towards e-mental health services for older adults. Emerging qualitative studies have investigated older adults' perspectives on technology to support good mental health and found that older adults were receptive to using technology to support mental health but experienced barriers such as lack of knowledge, the impact of low mood and fear of consequences (Andrews et al., 2019). This finding is supported by study 1 which built upon the literature base for understanding barriers toward MMHI use for older adults.

However, there is yet to be a quantitative enquiry of attitudes towards MMHIs for older adults. Investigating determinants of attitudes for older adults can provide insights into appropriate ways in which overall uptake for this age group can be improved by alleviating concerns and improving overall attitudes. In order to address these gaps in the literature, the current study aims to draw upon previous literature to identify potential predictors of attitudes using the Attitudes towards Psychological Online Intervention (APOI) scale (Schröder et al., 2015).

The findings from chapter five led to the inclusion of perceptions of data security, technology-self efficacy, attitudes towards apps and e-awareness in the current study. Effort expectancy was also included as it was identified as a barrier to the uptake of MMHIs in chapter five but also because it is reflected in the TAM as perceived ease of use – defined as the extent to which a person believes that using a system will be free of effort (Venkatesh & Davis, 2000). Furthermore, in order to be inclusive with the variables that were chosen, additional predictors based on previous literature that have examined attitudes in other populations were included. For example, severity of depression symptoms, attitudes towards general mental health help seeking and e-health literacy were all identified as important determinants of attitudes and therefore were included in this study also to explore whether the findings can be replicated in an older adult sample. The potential predictors of APOI are outlined below.

6.2.1 Technology-Related Factors

6.2.1.1 Perception of Data Security

The importance of guaranteed security and privacy for information sent specifically over a mobile phone has been identified as an important contributor to attitudes towards the use of

mobile phones for mental health monitoring and self-help (Proudfoot et al., 2010). Wozney et al., (2017) recognise that there is a lack of knowledge and expertise around cybersecurity in online health care – a finding supported by interviews with therapists who raised concerns over data protection and security (Waller & Gilbody, 2009). In terms of acceptance, data protection has been identified as a reason for discontinuation of an intervention by participants (Doherty et al., 2012) and therefore is included in the current study as a potential predictor of attitudes towards MMHIs.

6.2.1.2 Technology Self-Efficacy

Technology self-efficacy is based on the concept of self-efficacy, defined as a person's belief in his/her own ability to perform a certain task (Bandura, 1977), and is a well-researched contributor in technology acceptance models as it relates to ease of use (Venkatesh, 2000). While technology self-efficacy is commonly referred to as computer self-efficacy, this study is interested in mental health apps rather than ones perceived ability to use a computer. Therefore, Holden & Rada, (2011) approach of using technology self-efficacy as a measure of self-efficacy using technology in general rather than remaining specific to computers was adopted.

Self-efficacy has been found to be a determinant of intention to use e-health by community dwelling older adults (de Veer et al., 2015) and intention to use self-help treatment (Musiat, Goldstone, & Tarrier, 2014). In the context of mental health related interventions, self-efficacy has also been found to be associated with interest in using Internet-delivered Cognitive Behavioural Therapy (ICBT) (Schneider & Hadjistavropoulos, 2014). Furthermore, in chapter five (study 1) it was found that older adults had concerns around their ability to use the interventions correctly.

6.2.1.3 App Use

Smartphones have been suggested to be an acceptable method of delivery for mobile mental health applications (Proudfoot et al., 2010) and mobile apps are being utilised to deliver these services. For example, in the UK there are a number of applications advertised by the National Health Service (NHS) that address mental health concerns in a number of different ways. However, the results from chapter five (study 1) found that older adults had negative attitudes towards the use of apps, despite the fact participants were smartphone owners and users. Therefore, given the exploratory nature of the current study, appraisals of apps were measured through the variable 'app use' in order to explore whether current app use and appraisal of their

usefulness would contribute to attitudes towards mental health intervention delivered through a smartphone application.

6.2.1.4 E-awareness

Awareness of MMHIs was identified as a barrier to use for older adults in chapter five (study 1) and was therefore included in the present study as a predictor variable. E-awareness, or knowledge or awareness about MMHIs (Apolinário-Hagen et al., 2018), has been consistently found to be an important factor in predicting attitudes and acceptance of MMHIs. While it has been identified as an understudied area (Apolinário-Hagen, Vehreschild, & Alkoudmani, 2017), particularly in older adults - studies have found that increased awareness is associated with positive attitudes. Apolinário-Hagen et al., (2017) found that participants generally had low awareness of MMHIs, which, in turn, led to a negative attitude toward them. However, increased awareness also leads to fewer perceived disadvantages and can predict the perceived circumstances under which MMHIs may be advantageous (Donovan, Poole, Boyes, Redgate, & March, 2015). It is important to note however, that Donovan et al., (2015) measured five beliefs and knowledge only predicted two of them. This therefore brings into question the extent to which awareness can determine attitudes. This consideration is supported by a qualitative study suggesting that for older adults, awareness is necessary but not sufficient to facilitate uptake of the use of technology for mental health support (Andrews et al., 2019). As a result, it is important to clarify the role awareness has in the formation of attitudes for older adults, as findings vary among younger samples and with no available data with a focus on older adults, this remains a gap in the literature.

6.2.1.5 Effort Expectancy

As an integral part in technology acceptance models such as UTAUT, effort expectancy is defined as the degree of effort required to the use of a system (Venkatesh et al., 2003); the easier to use a system is perceived to be the lower the effort expectancy. Given the role of effort expectancy in UTAUT, effort expectancy has frequently been used as a predictor of acceptance (Baumeister et al., 2014; Ebert et al., 2015). Ebert et al., (2015) found that an acceptance facilitating intervention improved perceived effort expectancy and lead to an overall improvement in acceptance, concluding that addressing drivers of acceptance can reduce misconceptions about MMHIs and barriers of intervention uptake.

Digital interventions have been praised for requiring very little effort compared to other treatment options (East & Havard, 2015; Wallin, Mattsson, & Olsson, 2016). However, in

chapter five (study 1) perceived effort was identified as a barrier to use for older adults, specifically the time investment required for meaningful engagement and motivation required to use such a system which informs the hypothesis for the role of effort expectancy in determining older adults' attitudes towards MMHIs.

6.2.1.6 E-Health Literacy

E-Health literacy is "the ability to seek, find, understand and appraise health information from electronic sources and apply knowledge gained to addressing or solving a health problem", and is based on six core skills, or literacies: traditional literacy, health literacy, information literacy, scientific literacy, media literacy and computer literacy (Norman & Skinner, 2006a). This has been consistently found to be a predictor of uptake in health apps (Bol, Helberger, & Weert, 2018) and therefore may be a useful predictor in determining the attitudes towards mental health apps in older adults.

Similarly, e-health literacy is concerned with the extent to which that potential users can find, understand and appraise information. This has specific relevance to the uptake of mental health apps for older adults who may not have heard of these before and need to appraise whether they are a suitable option for their needs. Previous literature suggests that frequency of seeking health information online was associated with differences in internet intervention attitudes - (Apolinário-Hagen et al., 2018), given that older adults have significantly lower levels of e-health literacy than younger generations (Paige, Miller, Krieger, Stellefson, & Cheong, 2018), it is a key factor that may determine attitudes towards MMHIs.

6.2.2 Health-Related Factors

6.2.2.1 Attitudes towards Seeking Professional Mental Health Support

Older adults are far less likely to seek professional mental health services than other age groups, but do not have negative help-seeking attitudes (MacKenzie et al., 2008), which suggests that older adults experience other barriers while accessing mental health care. Given that MMHIs are suggested to overcome barriers to mental health support as they offer more flexibility in how they deliver intervention, attitudes towards seeking professional mental health support may predict attitudes towards MMHIs. However, contrary to the suggested benefits, Apolinário-Hagen, Vehreschild, and Alkoudmani, (2017) found that internet delivered therapies are perceived to be less compatible with work and life conditions than traditional psychological services. Furthermore, Hobbs, Joubert, Mahoney, and Andrews, (2018) conclude older adults prefer non-talking based therapies and suggests that internet delivered

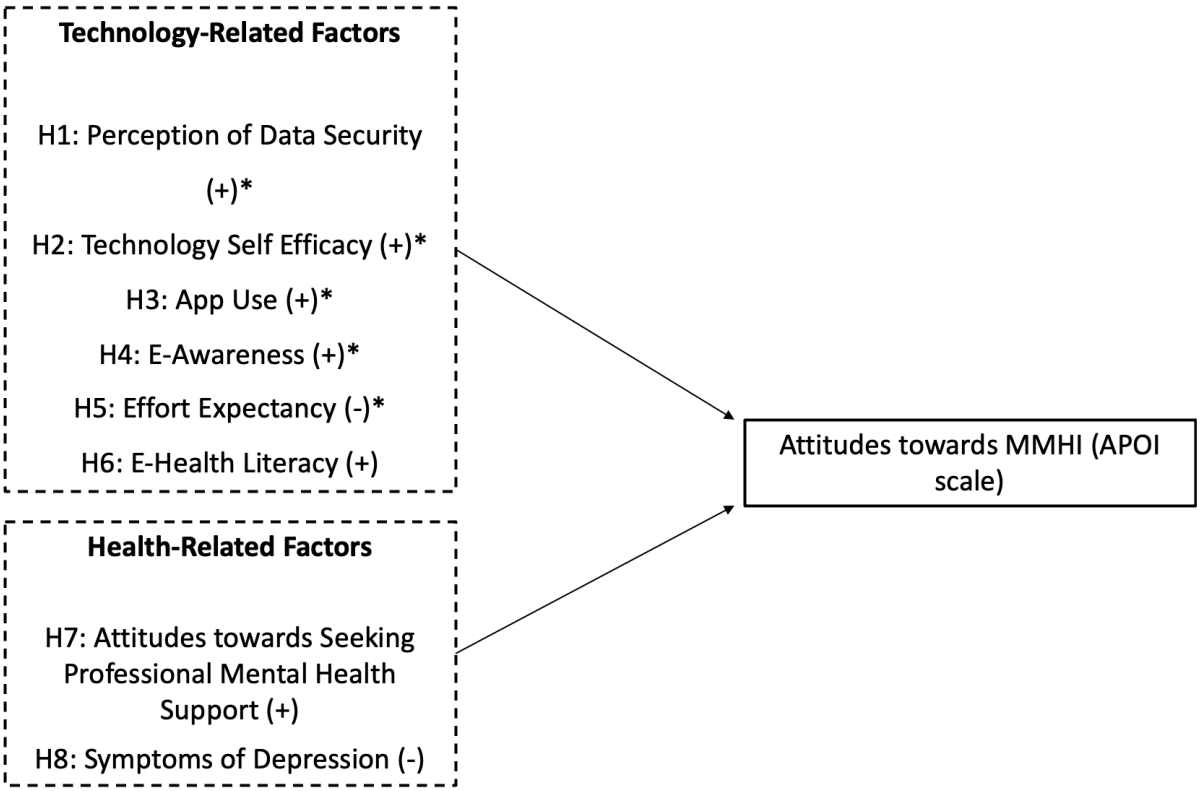
CBT may be less confronting and therefore a more attractive option for older adults seeking help from their GP. However, it is not yet established whether attitudes towards seeking professional mental health support influence attitudes towards MMHIs in older adults.

Attitudes towards seeking mental health help services have been measured by the Inventory of Attitudes towards Seeking Mental Health Help Services scale as it presents a number of psychometric benefits over more traditional scales such as the Attitudes Toward Seeking Professional Psychological Help Scale (Mackenzie, Knox, Gekoski, & Macaulay, 2004). This scale conceptualises attitudes as a function of three psychometric measures: psychological openness, indifference to stigma and help-seeking propensity. Given the strong psychometric properties of this scale (Mackenzie et al., 2004) and the relevance of the sub-scales, it was decided that it was necessary to include each subscale as an individual predictor of attitudes to explore the extent to which each facet determined overall attitudes in the context of mobile based interventions.

6.2.2.2 Symptoms of Depression

Depression symptom severity has been included as a predictor in a number of studies, however mixed findings have been reported for their role in predicting attitudes towards MMHIs. For example, some studies have found that participants with a greater severity of symptoms are prepared to use a mobile phone program more often and for longer periods (Proudfoot et al., 2010), and that symptom severity predicts interest in participating in an online treatment (Crisp & Griffiths, 2014). However, some studies report the opposite effect in that greater severity of symptoms leads to less positive attitudes towards MMHIs (Gun et al., 2011).

Conversely, other studies have found no evidence to suggest that symptom severity has any influence on acceptance or attitudes towards MMHIs. March et al., (2018) found that symptoms of depression were not determinants of intention to use e-mental health services however there was some evidence to suggest that increased symptoms of depression lead to an increased preference for online support. Furthermore, Schröder et al., (2017) report that severity of symptoms were not associated with attitudes towards internet interventions, as measured by their APOI scale (Schröder et al., 2015).



* Factors directly informed by study 1 are indicated by an asterisk

Figure 6: A Visual Representation of Predictors and Hypothesised Associations.

6.2.3 Objective

This study aimed to investigate older adult's attitudes towards MMHIs and identify determinants of older adult's attitudes that may contribute to older adult's uptake of MMHIs. Specifically, this study aimed to answer the research question: What are the determinants of older adult's attitudes towards mobile mental health interventions? In answering this research question, a number of hypotheses were devised as highlighted in Figure 6:

- H1: Perception of data security will positively predict attitudes
- H2: Technology self-efficacy will positively predict attitudes
- H3: App use will positively predict attitudes
- H4: E-awareness will positively predict attitudes
- H5: Effort expectancy will negatively predict attitudes
- H6: E-Health literacy will positively predict attitudes
- H7: Attitudes towards seeking professional mental health support will positively predict attitudes
- H8: Symptoms of depression will negatively predict attitudes

6.3 Method

6.3.1 Study Design and Participants

A cross sectional web-based survey was completed by 298 retired older adults (mean age 68.19, standard deviation (SD) = 6.62). All participants were recruited from the United Kingdom (UK) as an online sample through an online recruitment panel (Qualtrics) and through social media channels (Facebook and Twitter). Inclusion criteria were: i) retired, and living in the UK ii) be at least 50 years of age, consistent with the Mental Health Foundations definition of 'later life' (Mental Health Foundation, 2018). Participants recruited through the Qualtrics panel were paid a small amount for taking part in the survey (<£2). A summary of demographic characteristics can be found in Table 3.

Table 3: Demographic Profile and Device Ownership

Gender	**n**	**%**
Male	144	48.8
Female	151	51.2
Nationality	**n**	**%**
English	252	85.4
Scottish	21	7.1
Welsh	13	4.4
Northern Irish	7	2.4
Other	2	0.7
Qualification	**n**	**%**
GCSE or equivalent	160	54.2
A-level or equivalent	75	25.4
Higher national Certificate	19	6.4
Higher National Diploma	15	5.1
First Degree (BA, BSc etc.)	61	20.7
Medical/Nursing/Mental health care Qualification	18	6.1
City and Guilds certificate	23	7.8
Recognised Trade Apprenticeship	18	6.1
Clerical/Commercial Qualification	20	6.8
Higher degree (MA, PhD etc.)	14	4.7
Member of a Professional Institute	24	8.1
Device ownership	**n**	**%**
Smartphone	219	74.2
Laptop	205	69.5
Tablet or iPad	186	63.1
Desktop Computer	118	40.0

6.3.2 Procedure

Ethical clearance was obtained from Northumbria University's Research Ethics Committee. Scales were adapted to measure psychological variables that were identified following the thematic analysis in Chapter 5.

Once the questionnaire had been created, an online recruitment panel (Qualtrics) was used to recruit the required number of participants. Participants could follow a Qualtrics web link which provided additional information about the study before continuing to the questionnaire. Consent was gained via two forced choice questions. To supplement the online sample, a link was also shared through social media channels (Facebook and Twitter). Data collection took place during June-July 2019. Upon completing the questionnaire, participants were debriefed.

6.3.3 Measures

6.3.3.1 Predictor Variables

6.3.3.1.1 Perceptions of Data Security

As there are no established scales to measure perceptions of data security of mental health related apps, a 3-item scale was devised to measure this. Each question started with the statement 'If I was using a mobile app for mental health support…' to ensure that participants were answering in the context of mobile apps for mental health support. The participants were then asked the three following questions i) 'All information I disclose would be treated in strict confidence' ii) 'I would fear that confidential information would come into the wrong hands' (reverse scored), iii) 'I believe no one could access my data without my permission'. The first two items in this scale were adapted from (Ebert et al., 2015).

6.3.3.1.2 Technology Self-Efficacy

Technology self-efficacy was measured using the 10 item scale developed by Holden and Rada, (2011), where participants are asked to rate how confident they are performing a number of tasks using technology. This was measured using a 10-point Guttmann scale, as is common with self-efficacy scales, where 1 = not confident and 10 = totally confident. Scores range from 10-100 with higher scores indicating higher technology self-efficacy.

6.3.3.1.3 App Use

App use was measured using a 5-item scale created for this study. The items for this scale were: 'I am always on the look-out for new apps to download onto my mobile device', 'I am confident in my ability to download an application from the app store or the Google Play Store', 'I

frequently browse the app store or Google Play Store on my phone or tablet', 'when using a tablet or smartphone, I spend the majority of my time using an app', 'I think mobile apps are useful'. These questions were answered on a 5-point Likert-scale ranging from 1=strongly disagree to 5=strongly agree.

6.3.3.1.4 E-Awareness

E-awareness was measured using two items created for this study, asking participants 'to what extent are you aware of mobile interventions for mental health?' and 'how much experience do you have using a mobile app for mental health?'. These items were also measured on a 5-point Likert-scale ranging from 1=strongly disagree to 5=strongly agree. Reliability for this scale was measured using the Spearman-Brown coefficient as recommended for two item scales.

6.3.3.1.5 Effort Expectancy

As there are currently no scales available that measure the expected effort expenditure of using a mobile based mental health intervention, a scale was developed by adapting questions from existing studies. An item was taken from Ebert et al., (2015). This item was 'using an internet-based intervention for mental health problems would cost me a lot of time and energy'. However, as this a multi-faceted question and therefore this item was split into two separate items to measure expectations of both time, and energy. Finally, a third item was taken from de Veer et al., (2015) – 'fits easily into my daily routine'. To improve the validity and to ensure these questions were answered in the context of mobile-based mental health interventions, questions were re-worded into 'If I was using a mobile app for mental health… i) it would cost me a lot of time, ii) it would cost me a lot of energy, iii) it would fit easily into my daily routine' (reverse scored). Participants were asked to rate the extent to which they agree with each statement on a 5-point Likert scale (1 = strongly disagree, 5= strongly agree).

6.3.3.1.6 E-health Literacy

The e-HEALS scale is a measure of e-health literacy (Norman & Skinner, 2006a). This scale consists of 8 items and uses a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). E-health literacy score was calculated by summing the score for each item with possible scores ranging from 8 to 40 with higher scores indicating higher e-health literacy. This scale has previously been validated within the older adult age group, with strong reliability ($\alpha = .94$) (Chung & Nahm, 2015).

6.3.3.1.7 Attitudes Toward Seeking Mental Health Services

The Inventory of Attitudes Toward Seeking Mental Health Services (IASMHS) is a scale designed to measure attitudes towards seeking mental health services. This is an adapted and extended version of the Attitudes toward Seeking Professional Psychological Help Scale (Fischer & Turner, 1970), but with improved psychometric properties (Mackenzie et al., 2004). This 24-item scale consists of three sub-scales each measured by 8 of the items: psychological openness, help-seeking propensity and indifference to stigma. This scale was measured on a 5-point Likert scale whereby 1=strongly disagree and 5 = strongly agree. In the development of this scale, Mackenzie et al., (2004) internal consistency for the full scale was α=.87. Cronbach's alpha for subscales ranged from .61 to .83 with most >.7.

6.3.3.1.8 Symptoms of Depression

The PHQ-9 was used to measure symptoms of depression (Kroenke, Spitzer, & Williams, 2001). This is a widely used, and well validated scale, including validation within the older adult age group (Phelan et al., 2010). The scale asks participants to rate how many times they have experienced a number of symptoms within the last two weeks. The scale consists of 9 items, each scored on a 0-3 Likert scale where 0 = not at all, 1 = several days, to 3 = nearly every day. Scores range from 0 – 27 with higher scores indicating more symptoms of depression.

6.3.3.2 Outcome variable

6.3.3.2.1 Attitudes towards Psychological Online Interventions

The Attitudes towards Psychological Online Interventions (APOI) is a 16 item scale that measures respondent's attitudes towards psychological online interventions (Schröder et al., 2015). It includes four dimensions (scepticism and perception of risk, confidence in effectiveness, technologisation threat and anonymity benefits) and is measured on a 5-point Likert scale where 1 = totally disagree and 5 = totally agree. Sub-scales can range between 4 and 20. These dimensions of attitudes can also be captured in a total score for the scale which ranges from 16-80 where a higher total score represents a positive attitude. The scale was introduced as in Schröder et al., (2015). The scale showed good internal consistency (α=.83).

6.3.4 Analytical Plan

Before quantitative analysis is undertaken it is first important to assess the data to identify any missing data or outliers. Next, descriptive statistics are presented to give an overview of the data and provide a summary of all of the variables measured. To support the descriptive

statistics, a correlation table is provided to provide a simple summary of the direction and strength of any associations between variables. To test the hypotheses of this study, multiple regression analysis was conducted to determine which, if any, significantly predicted total APOI score. Multiple regression is suitable for predictive studies with one dependent variable and more than one independent variable. The predictor variables in the regression model consisted of symptoms of depression, app use, e-health literacy, e-awareness, effort expectancy, perception of data security, technology self-efficacy, and the three subscales of Attitudes toward seeking professional psychological help scale (IASMHS); psychological openness, help seeking propensity and indifference to stigma. The APOI total score was set as the dependant variable. All data analysis was conducted using SPSS and all significance testing was measured at the $p < .05$ level.

6.4 Results

Prior to conducting the multiple regression, the assumptions of the multiple regression were tested. P-P plots were examined and did not show any significant deviation from the normality line, therefore meeting the assumption of normality. VIF factors were below 1.646 and therefore indicates that there was no collinearity within the data. A visual assessment showed the data meeting the assumption of homoscedasticity. Finally, the Durbin-Watson statistic was used to test the independent errors assumption. Durbin-Watson was 2.024 for the regression test and therefore suggests that the independent errors assumption was met.

One participant was removed due to not successfully passing the attention check. Mahalanobis Distance was used to test for multivariate outliers. Two further data points showed significant ($p<.001$) Chi Square values and were therefore removed from further analysis to avoid likely leverage on the regression.

6.4.1 Descriptive Statistics

Descriptive statistics are presented in Table 4, with the Cronbach's alpha for each variable also presented as a measure of internal reliability of scales used within this study.

Table 4: Study 2 Table of Mean and Standard Deviation of All Variables (N=298)

Predictor variables	Mean (SD)	Cronbach's alpha (α)
Technology variables		
Perception of data security	9.83 (2.91)	.81
Technology self-efficacy	65.72 (18.99)	.95
App Use	14.20 (4.44)	.82

E-awareness	3.05 (1.35)	.64*
Effort Expectancy	10.41 (2.27)	.72
e-Health Literacy	29.11 (5.96)	.91
Health-related variables		
Symptoms of depression	3.26 (4.49)	.86
IASMHS Psychological Openness	17.35 (6.03)	.79
IASMHS Help Seeking Propensity	22.78 (5.35)	.83
IASMHS Indifference to Stigma	23.61 (6.03)	.66
Outcome variable		
APOI total score	45.54 (8.05)	.83

*Spearman-Brown was calculated for this variable as it is a two-item scale

Table 5: Summary of Attitude Assessment Measure with the APOI Attitude Measure

Sub-scale	Mean (SD)
Scepticism and perception of risks	11.36 (2.95)
Confidence in effectiveness	10.57 (3.01)
Technologisation threat	9.14 (2.75)
Anonymity benefits	12.40 (2.92)

Table 5 displays the sub-scale analysis of the APOI scale. Anonymity benefits had the highest mean (12.40) whereas technologisation threat had the lowest mean (9.14) indicating that participants have positive attitudes towards the fact that MMHIs are anonymous and do not perceive the fact that it is delivered through technology to be an issue. Scepticism also scored quite highly (11.36) indicating that older adults are also quite sceptical of MMHIs.

Table 6: Pearson Correlation of All Variables

	Perception of data security	Technology self-efficacy	E-awareness	Effort Expectancy	E-health literacy	App Use	Symptoms	IASMHS: Indifference to stigma	IASMHS: Psychological openness	IASMHS: Help seeking propensity	Attitudes total
Perception of data security	1										
Technology self-efficacy	.159**	1									
E-awareness	.054	.066	1								
Effort Expectancy	-.342**	-.155**	.007	1							
E-health literacy	.216**	.394**	.313**	-.089	1						
App Use	0.104	.457**	.307**	-.177**	.285**	1					
Symptoms	-.087	-.048	.072	-.026	-.006	.181**	1				
IASMHS: Indifference to stigma	.294**	.063	-0.072	-.235**	0.037	-.075	-.271**	1			
IASMHS: Psychological openness	.226**	.117*	.201**	-.229**	.167**	.116*	.013	.376**	1		
IASMHS: Help Seeking Propensity	.327**	0.079	.153**	-.224**	.314**	-.036	-.244**	.474**	.332**	1	
Attitudes Total	.459**	.157**	.214**	-.371**	.239**	.157**	.012	.118*	.248**	.163**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

All identified determinants significantly correlate with the APOI total score, except for symptoms of depression. Pearson's *r* values ranged from *r* = .157 (technology self-efficacy, App Use) to *r* = .459 (perception of data security). It is also worth noting that effort expectancy had a negative correlation of *r* = -.371 which was expected in line with H5 (Table 6).

6.4.2 Determinants of Attitudes

To identify significant determinants of attitudes a multiple regression was conducted on all variables with the total APOI score as the dependent variable. The overall regression model was significant, explaining 32% of the variance ($F(10, 287) = 13.532$, $p < .001$). There were three significant predictors in this model: e-awareness, and data security as positive predictors of attitude with effort expectancy as a negative predictor (Table 7).

Table 7: Linear Regression of Predictor Variables on APOI Total Score

Predictor	B	SE B	β	*t*	*p*	Hypothesis
Constant	37.592	3.708		10.139	<.001	
Technology Factors						
Data Security	0.996	0.152	.359	6.536	<.001***	H1: Supported
Technology self-efficacy	0.010	0.025	.023	0.382	.703	H2: Not supported
App Use	-0.059	0.109	-.033	-.544	.587	H3: Not supported
E-awareness	0.975	0.330	.163	2.954	.003**	H4: Supported
Effort Expectancy	-0.876	0.192	-.247	-4.570	<.001***	H5: Supported
e-health literacy	0.131	0.080	.097	1.640	.102	H6: Not supported
Health-related Factors						
PHQ-9	-0.001	0.095	.000	-0.007	.995	H8: Not supported
Indifference to Stigma	-0.060	0.082	-.045	-0.729	.467	H7: Not supported
Psychological Openness	0.143	0.075	.107	1.909	.057	H7: Not supported
Help Seeking Propensity	-0.124	0.094	-.082	-1.315	.189	H7: Not supported

R^2 = .320
** p < .01
*** p < .001

6.5 Discussion

This study aimed to investigate the psychological variables that determine older adult's attitudes towards MMHIs. For overall attitudes, the technology-related variables: perception of data security, effort expectancy and e-awareness were all identified as significant predictors which highlights their importance in older adult's attitudes towards MMHIs. However, neither symptoms of depression nor any of the attitude towards seeking mental health support sub-scales were significant predictors from the health-care variables, contrary to suggestions from previous literature.

Perceptions of data security was the strongest predictor of attitudes in this study. This suggests that older adults' attitudes are largely shaped by the extent to which these mental health interventions may keep data relating to their mental health secure. This is an important finding as older adults show concern around sharing mental health information with technology due to the stigma associated with mental health as a security breach could damage the user's social image (McNeill et al., 2017).

The finding that perception of data security positively predicts attitudes for older adults supports a wide range of literature suggesting that concerns of privacy and data security are a pervasive concern (Hennemann et al., 2016; Torous et al., 2018). This finding also supports qualitative data suggesting that perception of privacy and security in mobile-mental health interventions is a major concern and a critical factor influencing acceptance (Vo, Auroy, & Sarradon-Eck, 2019). While providing support for previous research, this study extends research by providing support for this finding in an older adult age group.

Effort expectancy was also a significant negative predictor of attitudes meaning that a low level of perceived effort was a significant predictor of positive overall attitudes. There is a myriad of support for effort expectancy as a determinant of acceptance, however it also highlights the importance of usability and adoption in everyday life (Hennemann et al., 2016). This is especially important for the older adult age group who may have lower levels of e-health literacy and technology self-efficacy. Furthermore, significant relationships between technology-efficacy and effort expectancy, e-awareness and e-health literacy were observed. This therefore supports the notion that MMHIs will be more suitable for older adults who are proficient in technology use (Handley et al., 2015).

Given the role of effort expectancy in technology acceptance models such as UTAUT (Venkatesh et al., 2003) and its applications to constructs such as 'perceived ease of use' in the TAM (Davis et al., 1989) it is perhaps unsurprising that a high effort expectancy for older adults led to negative attitudes. The effort requirement of a particular technology has consistently been identified as a factor determining acceptance of technology. Future research should explore the usability and aesthetic design of these applications. Aesthetics have been found to influence perceptions of usability prior to use of the system (Tractinsky, Katz, & Ikar, 2000), although the actual usability experienced through use of the system can then mediate the perception of the aesthetics (Hamborg, Hülsmann, Kaspar, & Bellotti, 2014). It would also be beneficial to apply the TAM to further to understand the role of the different constructs in the uptake of MMHIs for older adults. Further research should explore the role of providing information about how commonly cited advantages of digital mental health care (such as convenience; Mewton, Sachdev, & Andrews, 2013; Musiat et al., 2014) may improve older adult's intentions to use.

E-awareness was a final significant predictor of attitudes, with a positive direction of the effect indicating that participants with lower perceived awareness had more negative attitudes. This finding supports previous literature concluding awareness and familiarity with digital interventions has been identified as a reason for negative attitudes (Musiat, Goldstone, & Tarrier, 2014b).

E-Awareness is consistently reported as being low in research samples, with typically younger age groups not being aware of electronic interventions for mental health (Apolinário-Hagen et al., 2018; Apolinário-Hagen et al., 2019; Apolinário-Hagen et al., 2017; Handley et al., 2015). The current study provides additional support for this finding, as only a very small percentage of participants had indicated any awareness of MMHIs. If younger samples report low E-awareness, it is unsurprising that this is replicated in older adults, who may be less up to date with technological alternatives for mental health support.

Acceptance Facilitating Interventions (AFIs) have been utilised with the aim of improving attitudes towards MMHIs by disseminating knowledge to potential users. The current evidence of AFIs shows promising evidence for the use of videos, text and PowerPoint presentations (Apolinário-Hagen et al., 2018; Baumeister et al., 2014; Donovan et al., 2015; Ebert et al., 2015; Lin, Faust, Ebert, Krämer, & Baumeister, 2018; Vis et al., 2018) and so this is a promising avenue to explore in the older adult age group (Chapter 8). However, to the best of

the authors knowledge, to date there is only one study which has included information about data security in an AFI (Baumeister et al., 2014).

Researchers also suggest that raising awareness of both the availability of digital mental health services and the evidence base to support their use are key to promoting use among older adults (Musiat et al., 2014). There is emerging evidence that AFIs are able to increase awareness and subsequently lead to improved attitudes (Baumeister et al., 2014; Casey, Joy, & Clough, 2013). However, whether this leads to improved intentions to use for older adults is yet to be examined.

All predictors in this study significantly correlated with attitudes measured by the APOI, except for symptoms of depression. Studies suggest emerging evidence that those with symptoms are likely to show increased interest in mobile interventions (March et al., 2018; Proudfoot et al., 2010), however the current study was not able to support this finding in an older adult sample. This is likely due to the fact that despite the large range of scores on the PHQ-9 (0-27), on average participants self-reported relatively low levels of depression symptoms.

Finally, subscale analysis identified that participants were most positive towards the anonymity benefits dimension of attitudes. As such, it seems that the commonly noted benefit of MMHIs being anonymous may be an aspect of MMHIs that are attractive to older adults, specifically those who fear being stigmatised by mental illness and have a low propensity to seek help (Clement et al., 2015; Schnyder, Panczak, Groth, & Schultze-Lutter, 2017). Using the e-Therapy Attitudes Measure (ETAM), Apolinário-hagen, Harrer, and Kählke, (2018) also found that in a public sample of adults, the anonymity provided by MMHIs was also viewed favourably.

6.5.1 Limitations

Although this study provides a significant contribution to the extant literature by being the first to quantitively examine older adult's attitudes to MMHIs, limitations must be noted. Firstly, online recruitment through Qualtrics recruitment panel was used to recruit participants for this study which limits the generalisability of study findings as our participant pool is likely to be more proficient with technology use in general. This may in turn have led to more positive attitudes towards MMHIs as these participants are likely to be less concerned by the 'Technologisation threat' subscale of the APOI.

Secondly, while this study aimed to provide quantitative support for an exploratory qualitative study and be as inclusive as possible in the determinants included, there may be other determinants of older adult attitudes towards MMHIs that were not included in the current study. Future research should aim to align with a theoretical model to test established variables such as perceived usefulness which is something that we aim to address in a future study of this research project.

Finally, as awareness of MMHIs is low, results obtained in this study relates to older adult's perceptions of MMHIs. While this still provides useful findings, it is possible that once older adults are more informed about MMHIs, their attitudes may change (Handley et al., 2015).

6.5.2 Conclusion

This study aimed to explore older adults' attitudes towards MMHIs. It is concluded that older adults are typically not aware of mobile mental health interventions and perceive the anonymity benefits offered by MMHIs as the biggest indicator of positive attitudes. Furthermore, perceptions of data security, awareness of mobile interventions and the perceptions of expected effort that older potential users of MMHIs have are important determinants of attitudes. Therefore, in efforts to increase uptake of potentially helpful and effective MMHIs in the older adult demographic, attempts should be made to increase awareness and alleviate concerns of data security and the effort required to effectively adopt this innovative delivery method of mental health care. While this study provides useful insight into determinants of use for older adults, the relationship between attitudes and intentions to use has not yet been confirmed in the context of older adults and MMHI intention to use. This is the question investigated in my next study (Chapter 7).

Chapter 7: Study 3: Older adult's Intentions to use Mobile Mental Health Interventions: An Extension of the Technology Acceptance Model

7.1 Chapter Introduction

This thesis aims to understand factors that influence attitudes and intentions to use MMHIs among older adults, while also aligning the research with theory. Chapters 5 and 6 were exploratory studies, first identifying factors that hinder older adults in the use of MMHIs, before examining which factors are important in the formation of attitudes towards MMHIs for older adults. While loosely guided by the TAM model, the research thus far has been exploratory in identifying the important factors that influence uptake and acceptance of MMHIs for older adults.

Given that MMHIs for depression have been found to be efficacious for the treatment of mild-moderate depression symptoms in older adults (Hobbs et al., 2018; Staples et al., 2016), it is important to consider how uptake can be facilitated in line with technology acceptance theory. In this study, the TAM was applied to the context of older adult's adoption of MMHIs and also to investigate whether older adult's perception of data security is a meaningful addition to the model within this context. As a result, the focus of this chapter is shifted towards the application of technology acceptance theory to the thesis' findings thus far for the application of MMHIs for depression. Consequently, this chapter draws upon theoretical literature and discusses theoretical implications of the findings and builds upon the previous two studies by aligning the research with the chosen theoretical model which has guided this thesis: the TAM.

7.2 Background

As discussed in Chapter 4, the Technology Acceptance Model (Davis, 1986) is a widely accepted model of technology acceptance and since its conception has been applied to a number of different research areas and contexts. The TAM was informed by the Theory of Reasoned Action (TRA) and models the relationship between behavioural intention to use and actual use of technology. Behavioural intention is influenced by attitudes towards use of the technology which in turn is predicted by Perceived Usefulness (PU) and Perceived Ease Of Use (PEOU) (Davis et al., 1989). Furthermore, the model also suggests that perceived usefulness has a direct relationship with behavioural intention.

In relation to research specifically focusing on older adults' adoption of health technologies, de Veer et al., (2015) applied the UTAUT model to investigate intention to use e-health for older people. The study concluded that older people were positive about the effort expectancy (reflected in the perceived ease of use factor in TAM) required to use e-health. However, older adults were less positive about the performance expectancy (reflected in the perceived usefulness factor in TAM). Furthermore, Hoque and Sorwar, (2017) found further support for the role of performance expectancy and effort expectancy in the adoption of m-health for the elderly. While these two studies adopted the UTAUT model, the findings reflect the TAM model due to the similarity of factors between the models, such as performance expectancy and effort expectancy of UTAUT reflecting the perceived usefulness and perceived ease in TAM. These two studies were also conducted in relation to m-health in general and not specifically relating to technologies for mental health, and so determinants of intentions to use for older adults in the MMHI context remains a gap in the literature.

Despite the fact that Holden and Karsh, (2010) found consistent support for the TAM in the acceptance of e-health, they also state that the TAM should be applied to more specific healthcare contexts and call for future research that should test additional variables that may strengthen the model. Furthermore, a scoping review further acknowledged that a large proportion of research focusing on acceptance of e-mental health services does not refer to applicable theoretical frameworks, while also acknowledging that these frameworks may need adapting to fit the e-mental health context (Apolinário-Hagen, et al., 2017). With consideration for these findings, data security has consistently been found to influence the uptake of MMHIs in a wide range of groups and ages including mental health professionals (Waller & Gilbody, 2009) and has been identified as a cause of negative attitudes towards MMHIs (Apolinário-Hagen et al., 2018; Hennemann et al., 2016). Following existing research focusing on overcoming barriers and identifying determinants of attitudes towards MMHIs for older adults, it was found that perceptions of data security (the extent to which participants thought their data would be safe) and prior awareness of their existence were two key factors for older adults (Pywell, Vijaykumar, Dodd, & Coventry, 2020; chapter 5). The role of perceived data security in the acceptance of e-health interventions is complex (Wilkowska & Ziefle, 2011). However, there is strong support for it being an important consideration for potential users across all age groups, with a number of studies concluding that perception of data security is a key driver of acceptance (Ebert et al., 2015; Shen et al., 2019; Stiles-Shields et al., 2017). Therefore, perception of data security was included in this current model with the aim of testing whether

perception of data security is a meaningful addition to the TAM in the context of MMHI uptake for older adults.

The extent to which people are aware of an intervention (e-awareness) has been identified as an important determinant of acceptance. In a systematic review of barriers and facilitating factors in the implementation of digital mental health treatments, awareness and knowledge of the existence of these novel interventions was a key determinant of acceptance for patients, as well as staff (Vis et al., 2018), a finding also supported by Simblett et al., (2019). Furthermore, evidence suggests that the acceptance of digital mental health treatments relies on the public's awareness of them, and the evidence available that supports their use (Musiat et al., 2014a). Further studies suggest that awareness of a digital mental health intervention also influences preference for treatment type and could be a reason for negative attitudes towards MMHIs (Apolinário-Hagen, et al., 2018). However, this has not yet been tested in the context of a theoretical model for MMHIs for older adults.

As a result of current literature, this study aims to test a theoretical model of TAM with perception of data security and e-awareness as additional determinants of attitudes and indirect predictors of intention to use (Figure 7).

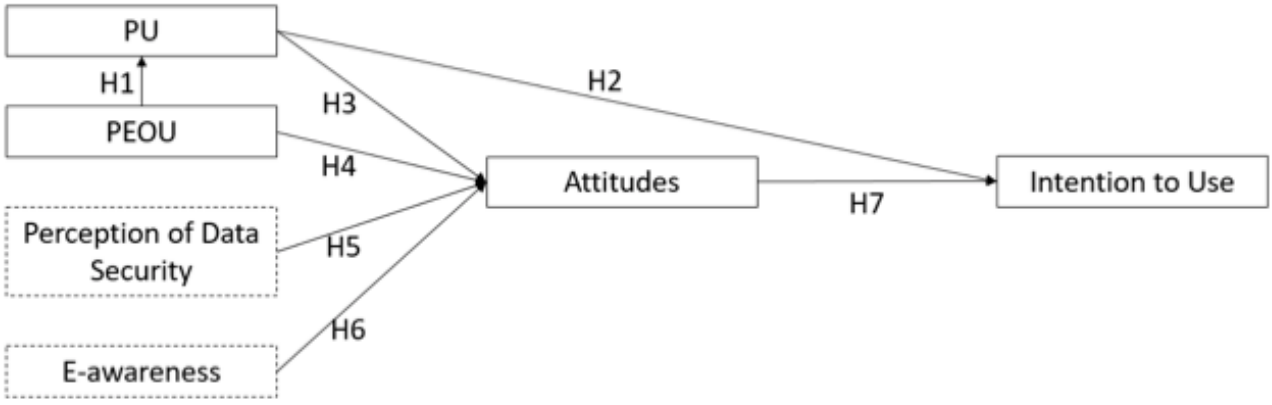


Figure 7: Proposed Extended Technology Acceptance Model

As well as the proposed hypotheses in the model, consistent with the TAM (Davis et al., 1989), it was also hypothesised that each determinant of attitudes would also indirectly predict intention to use, with attitudes acting as a mediator.

The study therefore aims to test the following hypothesis:

H1: Perceived ease of use will positively predict perceived usefulness

H2: Perceived usefulness will positively predict intention to use

Attitudes will be positively predicted by Perceived usefulness (H3), Perceived ease of use (H4), Perception of data security (H5) and e-awareness (H6).

H7: Attitudes will positively predict intention to use

Finally, attitudes will mediate the relationship between perceived usefulness and intention to use (H8), perceived ease of use and intention to use (H9), perception of data security and intention to use (H10), e-awareness and intention to use (H11) and perceived usefulness will also mediate the relationship between perceived ease of use and attitudes (H12)

7.3 Method

7.3.1 Participants

The questionnaire was completed by 321 retired older adults; however, eight participants were removed from the data set as they had failed one or more attention checks. As a result, 313 participants were included for further analysis (M^{age} = 63.89, Standard deviation (SD) = 6.55). According to Hair, Ringle, & Sarstedt, (2011a), this sample size is more than adequate for Structural Equation Model (SEM) analysis, and is above the critical sample of 200 needed for SEM analysis (Garver & Mentzner, 1999). All participants were recruited through Prolific Academic, to ensure good quality data was collected (Palan & Schitter, 2018; Peer, Brandimarte, Samat, & Acquisti, 2017). Participants were invited to complete the study if they met the inclusion criteria which were: i) over the age of 50, consistent with the Mental Health Foundation's definition of later life (Mental Health Foundation, 2018), ii) retired iii) living in the United Kingdom. A summary of the demographic characteristics of the sample for this study can be found in Table 8.

Table 8: Demographic Characteristics of Sample

Gender	**n**	**%**
Male	124	39.6
Female	189	60.4
Nationality	**n**	**%**
English	258	82.4
Scottish	27	27
Welsh	13	13
Northern Irish	7	7

Other	8	8
Qualification	**n**	**%**
GCSE or equivalent	183	58.5
A-level or equivalent	125	39.9
Higher national Certificate	26	8.3
Higher National Diploma	17	5.4
First Degree (BA, BSc etc.)	130	41.5
Medical/Nursing/Mental health care qualification	13	4.2
City and Guilds certificate	36	11.5
Recognised Trade Apprenticeship	9	2.9
Clerical/Commercial Qualification	33	10.5
Higher degree (MA, PhD etc.)	43	13.7
Member of a professional institute	36	11.5
Device Ownership	**n**	**%**
Smartphone	277	88.5
Laptop	226	72.2
Tablet or iPad	224	71.6
Desktop Computer	156	49.8
MMHI Use	**n**	**%**
Past use of MMHI	13	4.2
Current use of MMHI	5	1.6

7.3.2 Materials

A questionnaire was developed based on previous literature to measure six variables: Perceived usefulness, perceived ease of use, perceptions of data security, E-Awareness, Attitudes and Behavioural intention. The survey instruments for each variable were adapted from relevant theory and existing literature and, where necessary, were modified to make them relevant to the context of MMHIs.

7.3.2.1 Perceived Ease of Use and Perceived Usefulness

Items for perceived ease of use and perceived usefulness were adopted from (Becker, 2016) due to the fact they were already adapted for the context of MMHIs and showed good

psychometric properties. Perceived usefulness consisted of six items and perceived ease of use consisted of 5 items. Both scales were measured on a 5-point Likert Scale ranging from one = 'strongly disagree' to five = 'strongly agree'. Becker (2016) observed strong Cronbach's alpha for perceived usefulness (α=0.88) and perceived ease of use (α=0.70).

7.3.2.2 Intention to Use

Behavioural intention was measured using a four item scale adapted from Baumeister et al., (2014). Behavioural intention was also measured on a five-point Likert scale ranging from one = 'strongly disagree' to five = 'strongly agree'. The original scale adopted by Baumeister et al., (2014) had good internal reliability (α=.87).

7.3.2.3 Perception of Data Security

A three-item scale measured perception of data security. This scale used a five-point Likert scale, ranging from one = 'strongly disagree' to five = 'strongly agree'. Each question started with the statement 'If I was using a mobile app for mental health support…' to ensure that participants were answering in the context of mobile apps for mental health support. The participants were then asked the three following questions i) 'All information I disclose would be treated in strict confidence' ii) 'I would fear that confidential information would come into the wrong hands' iii) 'I believe no one could access my data without my permission'. The first two items in this scale were adapted from Ebert et al., (2015), with the third item added to remain consistent with chapter 6 (study 2).

7.3.2.4 E-Awareness

E-Awareness was measured using the two items created in chapter 6, asking participants 'to what extent are you aware of mobile interventions for mental health?' and 'how much experience do you have using a mobile app for mental health?' Responses were measured on a 5-point Likert Scale ranging from one = 'strongly disagree' to five = 'strongly agree'.

7.3.2.5 Attitudes

Finally, general attitudes towards MMHIs was measured using Dabholkar and Bagozzi, (2002) 4 item semantic-differential attitude scale and adapted to fit the context of MMHIs. This was measured on a 7-point bipolar scale (good-bad, favourable-unfavourable, pleasant-unpleasant and beneficial-harmful), consistent with other studies (Davis et al., 1989; Yang & Yoo, 2004).

This scale has previously been shown to have good internal reliability by Dabholkar and Bagozzi, (2002) with α=0.85. All items can be seen in Appendix 2.

7.3.3 Procedure

Before data collection, ethical approval was granted from Northumbria University's Department of Psychology Ethics Committee. Following ethical approval, questions were inserted into Qualtrics and was released on Prolific to 10% of the total sample size as a pilot study. After reviewing positive feedback from participants, it was deemed that the study was suitable to release and so the survey was then opened up to collect the full sample. Participants were paid £1.05 for their participation in the study, an amount deemed 'fair' by Prolific. Following completion of the questionnaire, participants received a debrief form and were thanked for their time. The debrief sheet also contained resources relating to depression and MMHIs for further information.

7.4 Results

7.4.1 Data Screening

Before completing factor analysis, key assumptions were checked. The E-awareness items displayed high levels of kurtosis; they were therefore removed from further analysis as they violate key normality assumptions of SEM. Research suggests that acceptable levels of kurtosis are -10 to +10 (Brown, 2015). While SEM is robust in dealing with small deviations from this (Griffin & Steinbrecher, 2013), the item E-awareness 2 displayed a kurtosis value of 19.37 and therefore had high deviation from acceptable ranges. To avoid risk of having a single item latent variable, which is not recommended for SEM analysis, this variable was removed and is instead reported as a descriptive statistic. As a result, it can be concluded that hypothesis 6 (H6) and hypothesis 11 (H11) are not supported.

7.4.2 Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) was performed with all of the indicators measuring latent variables to explore the factor structure of the following constructs: Perceived usefulness, perceived ease of use, perception of data security, attitudes, and intention. Given that the proposed theoretical model expected five factors, fixed factor extraction was selected for five factors. Kaiser-Meyer-Olkin (KMO) was "good" at .893 and Bartlett's Test of Sphericity was significant ($p<.001$). These findings suggest that the data was therefore suitable for EFA.

The 22 items measuring the five factors from the initial scales were entered into the EFA with Maximum Likelihood Estimation using Promax rotation. Factor loadings lower than .30 were supressed.

Due to poor loadings (<0.5), the following items were removed from the EFA: perceived usefulness 1, perceived usefulness 5, perceived usefulness 6, perceived ease of use 4, intention to use 3 and intention to use 4. After iterating until strongly loading items were identified, PEOU1 loaded more strongly on to the perceived usefulness factor. After evaluation of the question 'I find it easy to get the benefits from a mobile mental health application', it was decided that this question was actually quite ambiguous and potentially explored both the ease of use, but also the benefits. Due to this, it is uncertain how participants interpreted this question and was consequently removed from further analysis. The final Pattern Matrix can be found in Appendix 3.

Following the removal of poorly loading items, 64.9% of the variance was accounted for with all Eigenvalues above the acceptable threshold of 1, as suggested by (Hinkin, 1998).

7.4.3 Confirmatory Factor Analysis

In order to confirm the factor structure of all scales, a Confirmatory Factor Analysis (CFA) was conducted using Maximum Likelihood (ML) method in AMOS version 25 (Appendix 4). The goodness of fit was tested against the following prominent fit indices for SEM models: Root Mean Square Error of Approximation (RMSEA), Tucker-Lewis Index (TLI), Normed Fit Index (NFI) Comparative Fit Index (CFI) and Standardised Root Mean Residual (SRMR). The fit statistics for the research model and recommended values are provided in Table 9.

Table 9: Goodness of fit indices for CFA Measurement Model

Model goodness-of-Fit Indices	Recommended Value	Observed value from the study	Reference
Goodness-of-Fit Index (GFI)	≥ .90	.953	(Hooper, Coughlan, & Mullen, 2008)
Adjusted Goodness-of-Fit Index (AGFI)	≥ .80	.932	(Yang & Yoo, 2004)
Normalised Fit Index (NFI)	≥ .95	.963	(Hooper et al., 2008)
Comparative Fit Index (CFI)	≥ .90	.990	(Hu & Bentler, 1999)

Standardised Root Mean Residual (SRMR)	≤ .08	.032	(Hair, Black, Babin, & Anderson, 2014)
RMSEA	< .07	.033	(Hair et al., 2014)

The chi-square test did not meet the recommended value, suggesting poor model fit χ^2 (95) = 126.37, p = 0.017. However, chi-square has been shown to be sensitive to large samples size, particularly when the sample is over 200 participants, which is the case for this study (Hoe, 2008). Therefore, based on the other fit indices the five-factor model was considered a good fit to the data. All item loadings onto latent variables were strong (≥ .6) and significant (p < .05).

Common method bias was examined using Harman's single factor test (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). With all items constrained to one variable, the total variance explained was 43.68%, which is lower than the threshold of 50%. Therefore, common method bias was not deemed an issue with this data set.

Table 10: Composite Reliability, Average Variance Extracted (AVE) and Fornell-Larker Discriminant Validity Test

	CR	AVE	DSEC	ATT	INT	PU	PEOU
DSEC	0.793	0.562	**0.749**				
ATT	0.937	0.787	0.540	**0.887**			
INT	0.928	0.865	0.393	0.774	**0.930**		
PU	0.815	0.597	0.413	0.821	0.753	**0.772**	
PEOU	0.822	0.541	0.374	0.582	0.519	0.482	**0.735**

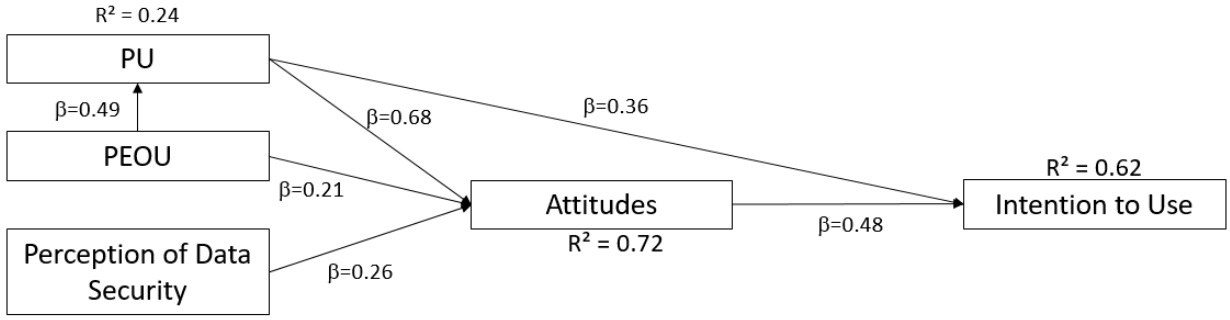
The composite reliability for all variables was above the .7 threshold. Furthermore, convergent validity was satisfied as all items loading were above the criteria of .6 and the AVE for all factors was above the threshold of 0.5 (Fornell & Larcker, 1981).

According to the Fornell-Larker criterion (Fornell & Larcker, 1981), discriminant validity is established if the square root of AVE is higher than the correlations to the other factors. Table 10 shows that perceived usefulness and attitudes did not show sufficient discriminant validity. While theory suggests that perceived usefulness and attitudes are highly correlated variables and was a hypothesised relationship, given the shortfalls of the Fornell-Larker Criterion in assessing discriminant validity (Henseler, Ringle, & Sarstedt, 2014), the Heterotrait-Monotrait

(HTMT) statistic was calculated for these two variables. According to the HTMT statistic, discriminant validity is achieved if the value is below the threshold of 0.85 (Henseler et al., 2014; Voorhees, Brady, Calantone, & Ramirez, 2015). The results from this test showed the HTMT for perceived usefulness and attitudes to be 0.82 and therefore it was concluded that there was sufficient discriminant validity to test the structural model.

7.4.4 Structural Model

The structural model (Figure 8) was analysed to test the hypothesised pathways. The model was able to explain 62% of the variance in intention to use, along with 72% of the variance in attitudes (Appendix 5). The path between perceived ease of use (PEOU) and perceived usefulness (PU) was significant (β = 0.49, *p*=.008), supporting hypothesis 1. The paths between perceived usefulness (PU) and attitudes (β = 0.68, *p*=.007), perceived ease of use (PEOU) and attitudes (β = 0.21 *p*=.013) and perception of data security and attitudes (β = 0.26, *p*=.005) were significant, therefore providing support for hypotheses 3, 4 and 5. Similarly, the direct path between perceived usefulness (PU) and intention to use was significant (β = 0.36, *p*=.015) supporting hypothesis 2. Finally, the path between attitudes and intention to use was also significant (β = 0.48, *p*=.006) providing support for hypothesis 7 (Appendix 6 and 7).



All relationships significant $p < .01$ level

Figure 8: Structural Model Showing Standardised Estimates

7.4.5 Mediation

Consistent with the TAM, mediation analysis was conducted to test hypothesis H8-H12. As hypothesised in H8, attitude mediated the relationship between perceived usefulness and intention, perceived ease of use and intention (H9) and perception of data security and intention (H10). Furthermore, perceived usefulness mediated the relationship between perceived ease of use and attitude, thus supporting hypothesis 12. Mediation significance values were tested using 2000 bootstrapped samples (Table 11) (Appendix 8).

Table 11: Mediation Analysis with Standardised Estimates

Hypothesis	Relationship	β (p-value)	Comments
H8	PU –> ATT –> INT	.470 (p = .001)	Supported
H9	PEOU –> ATT –> INT	.131 (p < .001)	Supported
H10	DSEC –> ATT –> INT	.129 (p = .001)	Supported
H12	PEOU –> PU –> ATT	.514 (p < .001)	Supported

7.5 Discussion

This study examined older adults' acceptance of mobile-based mental health interventions by extending the TAM to include perception of data security. While TAM literature has been rapidly expanding into e-health, this study adopts the TAM to explore acceptance of mobile-based mental health interventions for treatment of depression symptoms, specifically among older adults. This study found support for the TAM in the MMHI context, with the model able to explain 72% of the variance in attitudes and 62% of the variance in intentions to use. Perceived usefulness and perceived ease of use were significant indirect predictors of intention to use with the relationship mediated by attitudes. Furthermore, this study also found that perception of data security is also a key addition to the model, significantly predicting intention with the relationship mediated by attitudes.

Consistent with previous TAM literature, perceived usefulness was the strongest predictor of attitudes, and overall intentions to use (Davis et al., 1989) (H2, H3). Therefore, older adults are more likely to use MMHIs if they appear to be useful to them. The role of perceived usefulness has been made clear through a number of studies aligning with technology acceptance theory. de Veer et al., (2015) found that for older people's adoption of e-health performance expectancy and effort expectancy (ease of use) were predictors of intention to use in the future. More specifically in relation to MMHIs, research has found that perceived usefulness can be improved through educational stimuli (Apolinário-Hagen et al., 2018). It has also been suggested that if mental health providers endorse and encourage the use of particular apps or services, then consumer performance expectancy may increase (East & Havard, 2015). However, this is yet to be investigated in an older adult sample.

Furthermore, perceived ease of use significantly predicted perceived usefulness (H1), attitudes (H4) and indirectly predicted intention (H8), consistent with the original TAM model (Davis, 1986). This finding supports existing TAM literature and extends its application to the context

of MMHIs. This study adds to the body of literature by replicating this finding in an older adult sample. Perceived ease of use has been identified as a variable of TAM that is most susceptible to change as a result of age (Hauk, Hüffmeier, & Krumm, 2018). However, the findings from this study suggest that for older adults in this sample, perceived ease of use remains an important factor in determining older adult's intentions to use MMHIs, with perceived usefulness as the strongest predictor. Therefore, successful adoption relies on older users perceiving the mobile intervention to be easy to use.

Perception of data security predicted attitudes towards MMHIs (H5) and indirectly predicted intention to use (H9). Consequently, perception of data security is a key aspect in the acceptance of MMHIs for older adults. This finding supports previous literature that user concerns over data security are a key driver of acceptance, and that by addressing these concerns, acceptance can be facilitated (Ebert et al., 2015). Furthermore, in a similar study applying an extended TAM to investigate acceptance of mobile health systems, data privacy had a significant effect on intention to use for patients (El-Wajeeh, Galal-Edeen, & Mokhtar, 2014). The importance of data security for acceptance of MMHIs is a key finding given the recent studies surrounding the poor data security practices of mobile apps for depression (Huckvale, Torous, & Larsen, 2019; O'Loughlin, Neary, Adkins, & Schueller, 2019).

The model also shows that perceptions of data security, in comparison to perceived ease of use, had a stronger influence on attitudes. This finding may be explained by the fact that the sample recruited online using Prolific Academic and are confident in their ability to use the technology (technology self-efficacy) and therefore perception of data security may be of more importance than the usability of the intervention itself. However, technology self-efficacy was not measured in this study and therefore calls for caution when interpreting these findings.

Based on the findings from previous studies investigating factors that may influence use of MMHIs in older adults, it was hypothesised in this study that e-awareness would predict attitudes and intentions to use. However, it was found that e-awareness had a kurtosis value that violated key assumptions of SEM analysis. Although this variable was not able to be included in the SEM model, it does highlight some key insights. This finding suggests that e-awareness was very low among the sample of older adults which is further corroborated by examining the past use and current use scores as only 5.8% of the sample indicated that they had either used an MMHI or were currently using one. This supports the findings from Chapter 6 (study 2) suggesting that e-awareness is low in older adults, but also supports literature

suggesting this may be a general finding across all age groups, including younger samples (Apolinário-Hagen et al., 2018).

7.5.1 Limitations

Structural Equation Modelling is a robust statistical technique to identify associations between factors. However, although the model may be robust in predicting older adult's intentions to use MMHIs, findings from this study suggest that awareness of MMHIs is low, and a measure of actual use of MMHIs was not included in the model. As such, the model cannot determine the extent to which this model can predict *actual* use of MMHIs, rather participants' intention to use them. While a measure of actual use was included in the questionnaire, rates of use were very low within the sample and so could not have been included within the model.

In addition to this, while this study provides a useful theoretical framework to inform studies aiming to increase intention to use MMHIs in an older adult sample, the cross-sectional approach does not determine whether this framework leads to actual use of MMHIs. Longitudinal investigation is therefore required to determine whether the proposed extension to the TAM results in future actual use of MMHIs.

Furthermore, the questionnaire was only available online and used Prolific Academic to recruit participants. Therefore, it is likely that the sample recruited are likely to be interested in research and be more interested in technology use. While this was necessary to recruit sufficient older adults, the commentary by Seifert et al, (2019) is acknowledged, describing the bias in recruitment of older adults regarding technological (in)ability when investigating MMHIs. As a result, future research should focus on training, education and support to increase participation but also to decrease dropout rates of older adults in research (Seifert et al., 2019).

Finally, this study was conducted within the context of MMHIs for the use of treatment of depression symptoms. The items for the questionnaire could be viewed to be general with no specific mention of depression, the participant information sheet and study advertisement stated that the context of the study is for depression. It is therefore unclear if the findings for the application of the TAM for uptake of MMHIs can be generalised to other mental health conditions. Further research replicating this study in the context of other mental health disorders would be salient to improve the theoretical foundation and reliability of findings.

7.5.2 Conclusions

This study extended the TAM to include perception of data security, and also test the theoretical model in a sample of older adults, within the context of MMHIs. Applying the TAM to an MMHI context, the current study represents a key step in understanding older adult's acceptance of mobile-based interventions for mental health. Using structural equation modelling a high percentage of intentions to use MMHIs was explained as a result of the model. Along with key determinants such as perceived usefulness and perceived ease of use, the current findings also suggest that perception of data security is a key factor in determining acceptance in older adults. Despite E-awareness not being included in the model, it provides further evidence for the fact that current use and awareness of MMHIs was low within this sample. As a result, the proposed model provides a strong theoretical foundation for 'acceptance facilitating interventions' (For example; Baumeister et al., 2015) to provide structured information to potential users and test whether alleviating data security concerns has an effect on intentions to use. As a result, the following chapter seeks to use the proposed theoretical model presented in this chapter to inform an experimental study which aims to develop and test stimuli to alter the attitudes towards and intentions to use MMHIs for older adults.

Chapter 8: Study 4: An Acceptance Facilitating Intervention to Improve Older Adult's Intention to Use MMHIs.

8.1 Introduction

The previous chapters have explored older adult's perceptions of MMHIs and with the aim of aligning the research with appropriate theory, this thesis presented an extended TAM that has been developed within the previous chapter. The extended TAM models the relationship between perceptions of data security and existing determinants of intentions to use MMHIs. This final study therefore aims to use the adapted TAM model presented in the previous chapter, and empirically test the role that knowledge of MMHIs and perceptions of data security has on older adult's perceptions of MMHIs.

8.2 Background

Previous research shows that limited prior knowledge of MMHIs leads to lower adoption rates (Carper, McHugh, & Barlow, 2013; Musiat et al., 2014b), suggesting that education may be an important tool in efforts to improve mobile mental health delivery to older adults. Uptake in the future can be facilitated by providing information on the effectiveness, accessibility and safety of MMHIs (Gun et al., 2011). As a result, AFIs have received increased attention as they show promising results of improving awareness and therefore acceptance of interventions. Acceptance facilitating interventions are referred to in a number of studies whereby educational stimuli are presented to participants using an experimental design, with the aim to alter and improve the participants perceptions of MMHIs, and therefore lead to 'acceptance' which has been conceptualised as 'intention to use' (Lin et al., 2018). Using this design, Casey, Joy, and Clough, (2013) examined the mode of information delivery and found that a text intervention was more successful in improving participants likelihood of using e-mental health services as opposed to the same intervention delivered by video. Building on this evidence, Apolinário-Hagen, Fritsche, Bierhals, and Salewski, (2018) investigated the impact of the information source on attitudes and intentions to use. The results showed that psychoeducational information improved attitudes towards use, especially an expert evaluation which included presenting scientific evidence of the efficacy of digital interventions, with an 'expert' such as a health professional as the source of the information. However, this study is limited by the lack of baseline measures, therefore baselines scores cannot be accounted for.

Consideration has also been given to the *type* of intervention provided for these studies. Evidence is available for the efficiency of video-based interventions (Ebert et al., 2015; Soucy, Owens, Hadjistavropoulos, Dirkse, & Dear, 2016), text-based intervention (Apolinário-Hagen, et al., 2018; Casey et al., 2013) and PowerPoint (Donovan et al., 2015). However, one study has directly compared the effectiveness of both video and text based interventions and found that text based interventions were more effective at improving intentions to use digital mental health in the future (Casey et al., 2013). Therefore, based on this evidence, it was decided that a text-based intervention would be used for the current study.

Furthermore, as information provided in these acceptance facilitating studies often address issues such as the evidence base of MMHIs and their accessibility, alongside measures of intentions and attitudes, secondary outcomes such as the effect on ease of use, and perceived usefulness are also measured. For example, Baumeister et al., (2014) included measures of performance expectancy (perceived usefulness) and effort expectancy (ease of use) and found changes in favour of the intervention group as a result of the information they provided to their participants, although this was not significant. However, with the inclusion of the same secondary outcomes, Ebert et al., (2015) were able to observe significant improvements in these outcomes as a result of their informational stimuli.

Despite evidence of acceptance facilitating interventions providing promising results for improving the acceptability of MMHIs, older adults have received very little attention within this area of research. Older adults typically have lower mental health literacy and computer literacy than their younger counterparts and so the way in which information is communicated to older adults is important (Arcury et al., 2020). Previous findings have identified that older adults would be more likely to use an MMHI if the recommendation came from a reputable source, such as the National Health Service (NHS) who may act as a 'trusted facilitator' (Pywell et al., 2020; Chapter 5). Furthermore, this study also showed that older adults value the privacy and security of their information, but also the anonymity that could be associated with participating in mental health treatment through digital alternatives. Therefore, providing information about the privacy practices of existing MMHIs may alleviate these concerns for older adults and lead to an improvement in determinants of use.

While previous research has shown the importance of data security concerns in the uptake of MMHIs, there is scarce inclusion of perceptions of data security in acceptance facilitating interventions. Ebert et al., (2015) addressed concerns of data security in a video intervention

and found a positive improvement in perceptions of data security compared to the control group. The authors conclude that proactively addressing drivers of acceptance can reduce misconceptions of mobile mental health interventions and as a result improve acceptance.

As a result of this evidence, this study aims to determine the extent to which providing information about MMHIs to older adults will impact on determinants of use for MMHIs. The study also aims to build on the evidence of Ebert et al., (2015) and examine the importance of data security information to determine the extent to which information about data security will lead to changes in attitudes and intentions to use within an older adult sample.

The following hypotheses have been devised for the current study:

H1: There will be a significant difference in intention to use between pre intervention and post intervention measures and across each experimental condition.

H2: There will be a significant difference in attitudes towards MMHIs between pre intervention and post intervention measures and across each experimental condition.

H3: There will be a significant difference in perceptions of data security between pre intervention and post intervention measures and across each experimental condition.

H4: There will be a significant difference in perceived usefulness between pre intervention and post intervention measures and across each experimental condition.

H5: There will be a significant difference in perceived ease of use between pre intervention and post intervention measures and across each experimental condition.

8.3 Methods

8.3.1 Design

A cross-sectional questionnaire was used which incorporated a 2 x 4 mixed design whereby the within subjects' factor (exposure) had two levels (pre-exposure and post-exposure) and the between subjects factor (data security information) had four levels: positive, negative, combined positive and negative and finally the control group, which received no data security information. The dependent variables were intention to use and attitudes. Secondary analysis was also run on three further dependent variables perceived usefulness, and perceived ease of use, and perception of data security, as these are important determinants of intentions to use identified by the extended TAM model.

8.3.2 Participants

The final sample consisted of 341 participants, (M^{age} = 65.17, SD = 6.35, range = 51 – 87). All participants were retired, lived in the UK, and over the age of 50, consistent with the Mental Health Foundation's definition of 'later life' (Mental Health Foundation, 2018). Participants were recruited from the panel Prolific Academic (Palan & Schitter, 2018) and were payed a small renumeration for their time (<£2). A summary of demographic characteristics can be found in Table 12.

Table 12: Study 4 Demographic Details of Sample

Gender	**n**	**%**
Male	154	45.2
Female	187	54.8
Nationality	**n**	**%**
English	288	84.5
Scottish	32	9.4
Welsh	8	2.3
Northern Irish	6	1.8
Other	7	2.1
Qualification	**n**	**%**
GCSE or equivalent	177	51.9
A-level or equivalent	118	34.6
Higher national Certificate	21	6.2
Higher National Diploma	20	5.9
First Degree (BA, BSc etc.)	122	35.8
Medical/Nursing/Mental health care qualification	23	6.7
City and Guilds certificate	35	10.3
Recognised Trade Apprenticeship	13	3.8
Clerical/Commercial Qualification	27	7.9
Higher degree (MA, PhD etc.)	42	12.3
Member of a professional institute	47	13.8
Use of MMHI	**n**	**%**
Past use of MMHI	6	1.8
Current use of MMHI	2	0.6

8.3.3 Materials

8.3.3.1 Primary Outcome Variables

8.3.3.1.1 Intention to Use

This scale was adapted from Baumeister et al., (2014) and consisted of four items. Items were measured on a five-point Likert scale ranging from one = 'strongly disagree' to five = 'strongly

agree'. An example question from this scale is 'in case I would feel mentally distressed or depressed, I can imagine using a mobile-based depression intervention if offered to me.' The original scale observed good internal reliability (α=.87), with comparable reliability observed in the current study across time-points (baseline: α=.89, post intervention: α=.90).

8.3.3.1.2 Attitude

General attitudes measure was adapted from Dabholkar and Bagozzi, (2002) and consisted of a four item semantic-differential attitude scale and adapted to fit the context of MMHIs. Questions all started with the statement; 'using a mobile mental health application would be…' and items were measured on a seven-point bipolar scale (good-bad, favourable-unfavourable, pleasant-unpleasant and beneficial-harmful). The original scale showed good internal reliability (α = 0.85), with comparable reliability found in the current study (baseline (α = .89) post (α = 0.95).

8.3.3.2 Secondary Outcome Variables

8.3.3.2.1 Perceived Usefulness and Ease of Use

Items for perceived ease of use and perceived usefulness were adopted from Becker, (2016) due to the fact the wording was already adapted for use in the context of MMHIs and showed good psychometric properties. Perceived usefulness consisted of six items and perceived ease of use consisted of 5 items. Both scales were measured on a 5-point Likert Scale ranging from one = 'strongly disagree' to five = 'strongly agree'. Becker (2016) observed strong Cronbach's alpha for perceived usefulness (α=.88) and perceived ease of use (α=.70). Comparable Cronbach's Alpha scores were found in the current study for perceived usefulness (baseline α=.88, post intervention α=.89) and perceived ease of use (baseline α=0.83, post intervention α=.87).

8.3.3.2.2 Perception of Data Security

To see whether the stimuli had the desired effect on perceptions of data security, a measure of perception of data security was taken using a three-item scale. This was a five-point Likert scale ranging from one = 'strongly disagree' to five = 'strongly agree'. Each question started with the statement 'If I was using a mobile app for mental health support…' to ensure that participants were answering in the context of mobile apps for mental health support. The participants were then asked the three following questions i) 'All information I disclose would be treated in strict confidence' ii) 'I would fear that confidential information would come into the wrong hands' iii) 'I believe no one could access my data without my permission'. The first

two items in this scale were adapted from (Ebert et al., 2015), with the third item added to remain consistent with Chapter 6 and 7. The scale showed good internal reliability at both pre (α = .81) and post (α = .91) measures.

8.3.3.2.3 Credibility

Source credibility was measured using three items. Participants were asked whether they trusted the information, believed the information and whether they learned something from the intervention. These items were measured on a 5-point Likert scale ranging from 1=strongly disagree to 5=strongly agree. This scale for credibility showed good internal reliability across all conditions (α = .81).

8.3.3.3 Stimuli for Intervention

Given that older adults were more likely to trust the information delivered by the NHS, the intervention was designed in form of a mock-up NHS webpage (Pywell, Vijaykumar, Dodd, & Coventry, 2020). The text for the general information was adapted from Apolinário-Hagen et al., (2018) and Apolinário-hagen et al., (2019) to suit English participants. The information about data security on the mock-up NHS webpage was created following a literature search and was specifically informed by the findings from Huckvale, Torous, and Larsen, (2019) and O'Loughlin, Neary, Adkins, and Schueller, (2019) with the text created to highlight the pertinent findings from these studies. Finally, in order to gather feedback on the designs of the stimuli prior to data collection, versions of the stimuli were shown to five participants who fit the recruitment criteria, to gather feedback and help shape the design of the intervention to improve validity. These five volunteers were shown all of the conditions in order to gather feedback across all conditions and were asked to consider both the design of the webpage and the text information. This process was conducted virtually as a result of the COVID-19 pandemic. Following feedback from volunteers, suggested changes were made accordingly. The final intervention for each condition can be seen in Appendix 9-12.

8.3.3.3.1 Control Condition

The participants in the control condition received general information about MMHIs which was presented on a mock-up of an NHS webpage. No information about data security was provided to this group. The text they received was:

> *Digital mental health interventions and therapies offer new opportunities to improve and/or expand care for people. Mental illness often remains untreated but digital interventions can be considered a means to bridge the gap and offer care to more individuals as they can be accessed through a mobile smartphone.*

Numerous scientific studies have shown the effectiveness of digital therapy for a broad range of psychological problems that can, for instance, arise from prolonged exposure to stress.

These digital interventions employ methods from cognitive behavioural theory that are also used in regular face-to-face therapy sessions. For instance, there are sessions to generally help cope with stress, to build resilience, to cope with mild or moderate depression, anxiety disorders or eating disorders.

One of the currently existing forms in internet-based guided programs that allow users to access online programs or online self-learning resources with the help of a therapist. Daily mobile apps can also be used. Users can also communicate with a therapist via e-mail, chat or video call. Flexibility regarding time and location is seen as a big advantage as they can be accessed any time and any place as long as you have a mobile device.

8.3.3.3.2 Positive Data Security Condition

In addition to the text presented above for the control condition, the positive condition received additional information about data security also presented on the mock-up of the NHS webpage:

These apps guarantee the security of the data the user provides by using encryption – this is a special way to code the data to make sure it cannot be read by anyone else.

Mental health apps also provide anonymity to the user and total confidentiality to the data provided, which means no one will ever be able to identify a specific user.

They also provide an extensive privacy policy where the user can see exactly how the data they provide will be used.

8.3.3.3.3 Negative Data Security Condition

In addition to the general text provided for the control condition, the negative condition received additional information about the data security also presented on the mock-up of the NHS webpage:

For some online interventions, confidentiality cannot be guaranteed. Recent reports show that some mental health apps share the mental health data (such as health status information from diary entries) with commercial businesses and advertisers and share results from depression questionnaires – without giving the user an option.

Furthermore, the privacy policies for these apps are often vague, misleading users as to how their data is used or sometimes leaving this information out of their privacy policy completely.

8.3.3.3.4 Combined Condition

The combined condition received the general information presented under section 8.3.3.3.1 along with both the positive data security information and the negative data security information presented in sections 8.3.3.3.2 and 8.3.3.3.3.

8.3.4 Procedure

Ethical approval was granted by Northumbria University Ethics Committee. Following creation of the intervention stimuli and feedback from prospective participants, a questionnaire was disseminated through Prolific's recruitment panel, who were redirected to the questionnaire host (Qualtrics). Participants provided a baseline score for each measure and then were randomised into 4 groups to determine what type of data security information they would receive: positive, negative, combined positive and negative, control. Participants were then shown the stimuli and were instructed to read the information carefully, there was no limit to exposure time, and participants were free to move on when they were ready. Following this, participants were asked to rate the sources credibility before providing post intervention scores for each scale. Finally, participants received a full debrief at the end of study.

8.4 Results

Following data collection, two participants failed two or more attention checks and consequently removed from further analysis. 2 x 4 mixed Analysis of Variance (ANOVA) (*exposure: pre- and post-* and *condition: control, positive, negative and combined)* was used to investigate the effect of the intervention for each dependent variable. A significance level of $p < .05$ was applied to all analysis.

Descriptive statistics shows that within the sample, uptake of MMHIs was low and that a low percentage of participants had actually searched for information about digital mental health services (5.3%) (Table 13).

Table 13: Current Use of Mental Health Smartphone Applications

Question	Answer	Frequency (%)
Have you ever used a mental health smartphone application in the past?	Yes	6 (1.8)
	No	333 (97.7)
	Unsure	2 (0.6)
Are you currently using a mental health smartphone application?	Yes	2 (0.6)
	No	338 (99.1)
	Unsure	1 (0.3)
Have you ever searched for information about digital mental health services?	Yes	18 (5.3)
	No	318 (93.3)
	Unsure	5 (1.5)

8.4.1 Randomisation Check

Verification of randomisation to conditions was tested with a MANOVA. Intervention condition was the independent variable and the baseline scores for each variable was entered as dependent variables. The MANOVA showed a non-significant result across conditions ($F(15, 919.668) = .994$, $p = .459$; Wilk's Lambda = .957, $\eta_p^2 = .015$. This indicates that participants have been successfully randomly allocated to conditions. Furthermore, a one-way ANOVA indicated no difference across experimental conditions for age of participants ($F(3, 337) = 71.721$, $p = .149$).

8.4.2 Source Credibility

Before measuring participant's post intervention scores, the intervention was rated for source credibility. Participants were asked if they trusted the information, believed the information and learned something from the intervention. Table 14 shows that credibility was rated very highly across each condition, with scores for trustworthiness, believability and whether participants had learnt something each achieving a high mean. Therefore, the webpage was successful at providing credible information.

Table 14: Source Credibility Mean and Standard Deviation for all Conditions

	Mean (SD)*
Trust	4.19 (.803)
Believe	4.16 (.806)
Learn	4.35 (.735)

MIN score = 1, MAX score = 5

8.4.3 Main Analysis

For the following mixed ANOVAs, the normality assumption was violated. However, due to the use of Likert scales, this is to be expected and research suggests that the statistics provided remain robust and accurate (Sullivan & Artino, 2013).

8.4.3.1 Primary Outcomes

8.4.3.1.1 Intention to Use

Table 15: Mean and Standard Deviation for Intention scores at baseline and post intervention

Condition	N	Mean (SD) at baseline*	Mean (SD) post intervention*
Control	79	12.86 (3.53)	13.23 (3.61)

Positive	87	12.37 (3.90)	12.56 (4.44)
Negative	89	12.15 (4.39)	10.84 (3.60)
Combined	86	12.90 (3.63)	12.57 (4.12)
Total	341	12.56 (3.88)	12.27 (4.12)

*MIN score = 4, MAX score = 20

A 2 x 4 mixed ANOVA shows there was a significant main effect for exposure, $F(1, 337) = 6.34$, $p = .012$, $\acute{\eta}^2_p = 0.018$, and Condition, $F(3, 337) = 2.64$, $p = .0497$, $\omega^2_p = 0.007$. There was also a significant interaction between Exposure and Condition, $F(3, 337) = 10.96$, $p < .001$, $\omega^2_p = 0.042$.

To examine the nature of the interaction, an ANOVA was conducted to examine the effect of Condition on Intentions, post intervention. A significant main effect was found for Condition, $F(3, 337) = 5.48$, $p = .001$, $\omega^2_p = 0.038$. Games-Howell post hoc analysis shows a significant difference between Control and Negative conditions ($p < .001$) and negative and combined condition ($p = .025$). Finally, although not significant, the comparison between negative and positive conditions approached significance ($p = .052$).

A series of repeated-measures ANOVA's were then conducted to examine the effect of exposure to the stimuli. Significant differences on intention to use between pre and post intervention measures were found for the control condition, $F(1, 78) = 4.272$, $p = .042$, and the negative condition, $F(1, 88) = 20.507$, $p < .001$, but not for positive condition ($p = .242$) or combined condition ($p = .192$). As shown by the means in Table 15, these results indicate that intentions to use significantly reduced for the negative condition, and significantly increased for the control condition. However, the mean scores slightly increased for the positive condition and slightly decreased for the combined condition, although these were not significant.

These results therefore show that at post intervention, intentions to use were significantly lower in the negative condition to the other three conditions and that intentions significantly improved in the control condition. Both groups that received the negative information (negative and combined) also showed a consistent reduction in intention, but this reduction was not significant in the combined condition (see Figure 9).

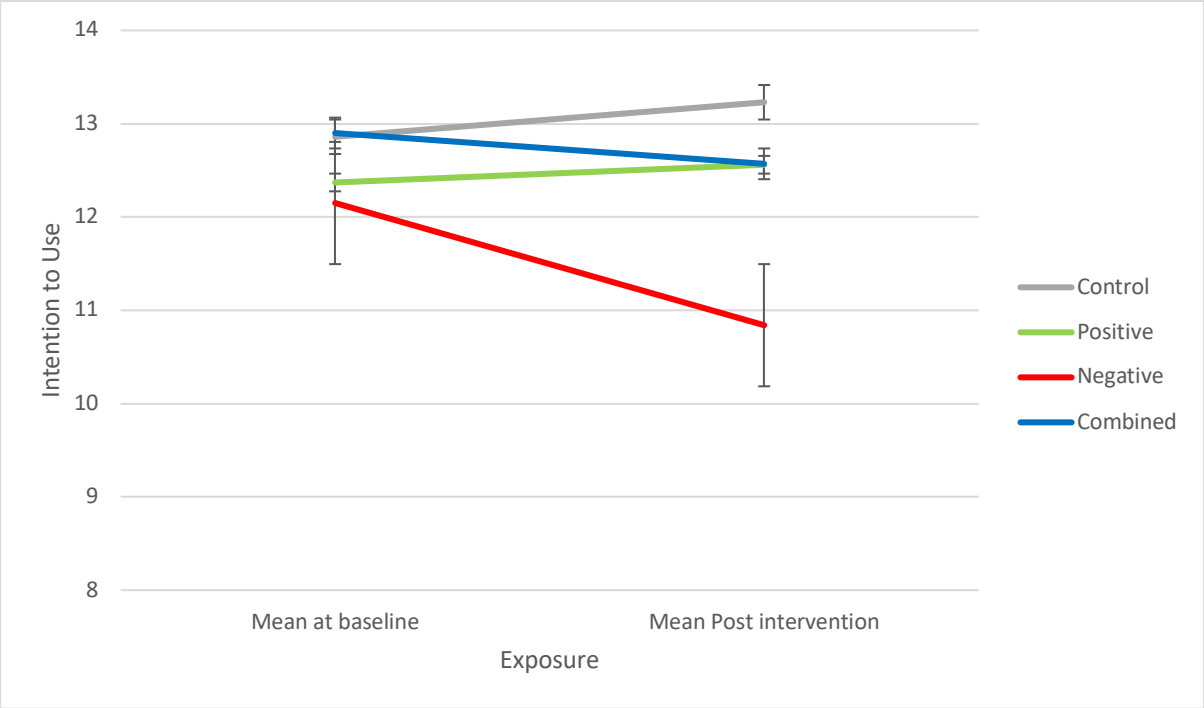


Figure 9: Intention to Use Mean Scores Pre and Post Intervention. Error bars Represent Standard Error.

8.4.3.1.2 Attitudes

Table 16: Means and Standard Deviation for Attitudes Pre and Post Intervention

Condition	N	Mean (SD) at baseline*	Mean (SD) post intervention*
Control	79	20.18 (3.15)	21.46 (3.91)
Positive	87	19.24 (3.79)	20.99 (4.46)
Negative	89	19.20 (4.28)	18.34 (5.17)
Combined	86	20.21 (3.88)	20.87 (4.09)
Total	341	19.69 (3.83)	20.38 (4.60)

*MIN score = 4 MAX score = 28

Significant effects were also found for exposure, $F(1, 337) = 22.30$, $p < .001$, $\acute{\eta}^2_p = 0.062$, and Condition, $F(3, 337) = 4.62$, $p = .003$, $\omega^2_p = .016$. There was a significant interaction between Exposure and Condition, $F(3, 337) = 15.87$, $p < .001$, $\omega^2_p = .061$.

To explore the interaction effect, an ANOVA was conducted to examine the effect of Condition on general attitudes post intervention. A significant difference of post intervention scores was found, $F(3, 337) = 8.68$, $p < .001$, $\omega^2_p = .063$. Games-Howell post-hoc analysis shows a significant difference between control and negative condition ($p < .001$), negative and combined condition ($p = .002$), and negative and positive condition ($p = .002$). Table 16 shows

that negative condition scores were significantly lower post intervention than the other three conditions and the control condition had the most positive attitudes post intervention.

A repeated-measures ANOVA was then conducted to examine the effect of exposure on general attitudes. A significant difference between pre and post intervention scores was found for positive condition, $F(1, 86) = 66.694$, $p < .001$), $\acute{\eta}^2_p = .437$, Negative condition, $F(1, 88) = 5.529$, $p = .021$, $\acute{\eta}^2_p = .059$, Combined condition, $F(1, 85) = 4.813$, $p = .031$, $\acute{\eta}^2_p = .045$, and for the Control, $F(1, 78) = 29.987$, $p < .001$, $\acute{\eta}^2_p = .278$. Figure 10 shows that attitudes improved as a result of exposure to the stimuli for control, positive and combined conditions but significantly reduced for the negative condition.

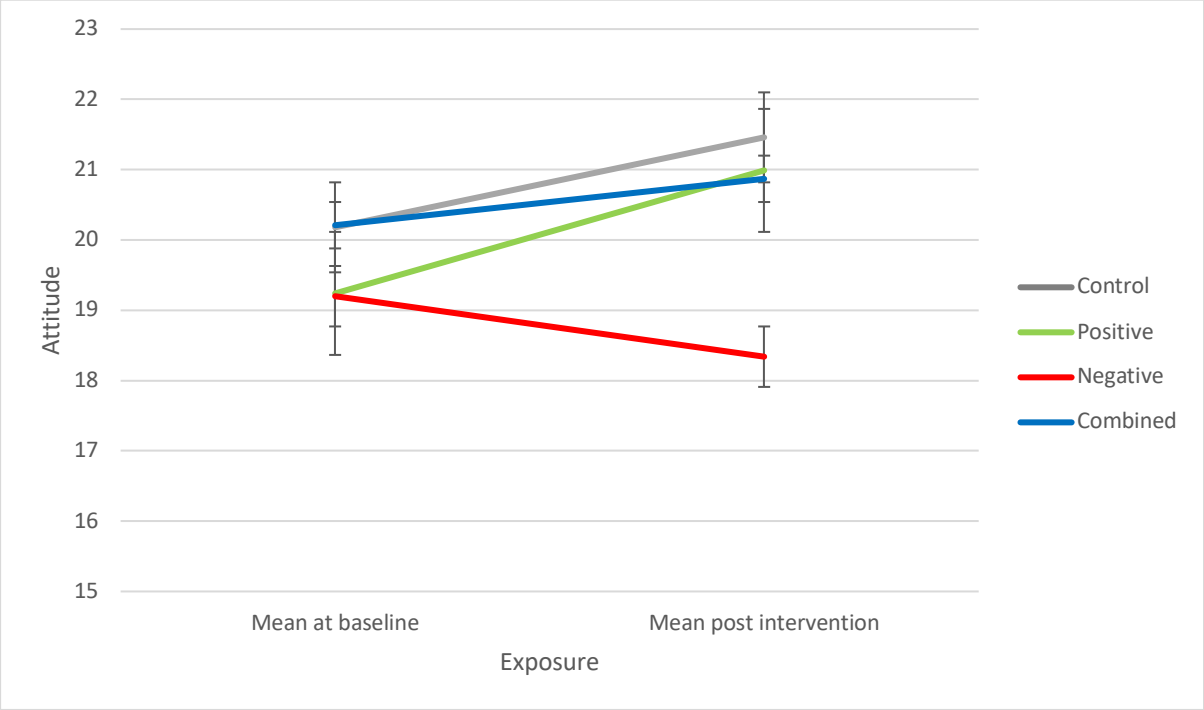


Figure 10: Attitudes Mean Score Pre and Post Intervention. Error bars represent Standard Error.

8.4.3.2 Secondary Outcomes

8.4.3.2.1 Perceived Usefulness

Table 17: Mean and Standard Deviation for Perceived Usefulness Pre and Post Intervention

Condition	N	Mean (SD) at baseline*	Mean (SD) post intervention*
Control	79	19.66 (4.29)	20.59 (4.40)
Positive	87	18.60 (4.48)	19.49 (4.35)
Negative	89	18.37 (5.16)	18.25 (5.33)

Combined	86	19.58 (4.02)	19.78 (4.55)
Total	341	19.03 (4.54)	19.50 (4.74)

*MIN score = 6, MAX score = 30

A 2 x 4 mixed ANOVA was conducted to examine the effect of Exposure (within) and Condition (between) on Perceived Usefulness. Significant main effects were also found for Exposure, $F(1, 337) = 9.75$, $p = .002$, $\acute{\eta}^2_p = 0.028$, and Condition, $F(3, 337) = 2.73$, $p = .044$, $\omega^2_p = .008$.

There was also a significant interaction between Exposure and Condition, $F(3, 337) = 3.05$, $p = .029$, $\omega^2_p = 0.009$. To explore the interaction a factorial ANOVA was conducted to examine the effect of Condition on Perceived usefulness, post intervention. A significant main effect was found for Condition, $F(3, 337) = 3.62$, $p = .013$, $\omega^2_p = .023$. Games-Howell post-hoc analysis shows a significant difference between Control and Negative condition (p=.012). The mean scores presented in Table 17 show that that the control condition had significantly higher scores for perceived usefulness at the post intervention measurement than the negative condition. No other comparisons were significant at post intervention.

A repeated-measures ANOVA was then conducted to explore change in scores from pre to post intervention. Significant differences were found for the control group, $F(1, 78) = 10.227$, $p = .002$, $\acute{\eta}^2_p = .116$, the positive condition, $F(1, 86) = 11.219$, $p = .001$, $\acute{\eta}^2_p = .115$, but not for the negative condition, $F(1, 88) = .168$, $p = .683$, $\acute{\eta}^2_p = .002$, or the combined condition $F(1, 85) = .314$, $p = .577$, $\acute{\eta}^2_p = .004$. This shows that in the control condition and positive condition, the stimuli significantly improved perceived usefulness of MMHIs. Figure 11 provides a visual representation of the differences of conditions pre-exposure and post-exposure of the stimuli.

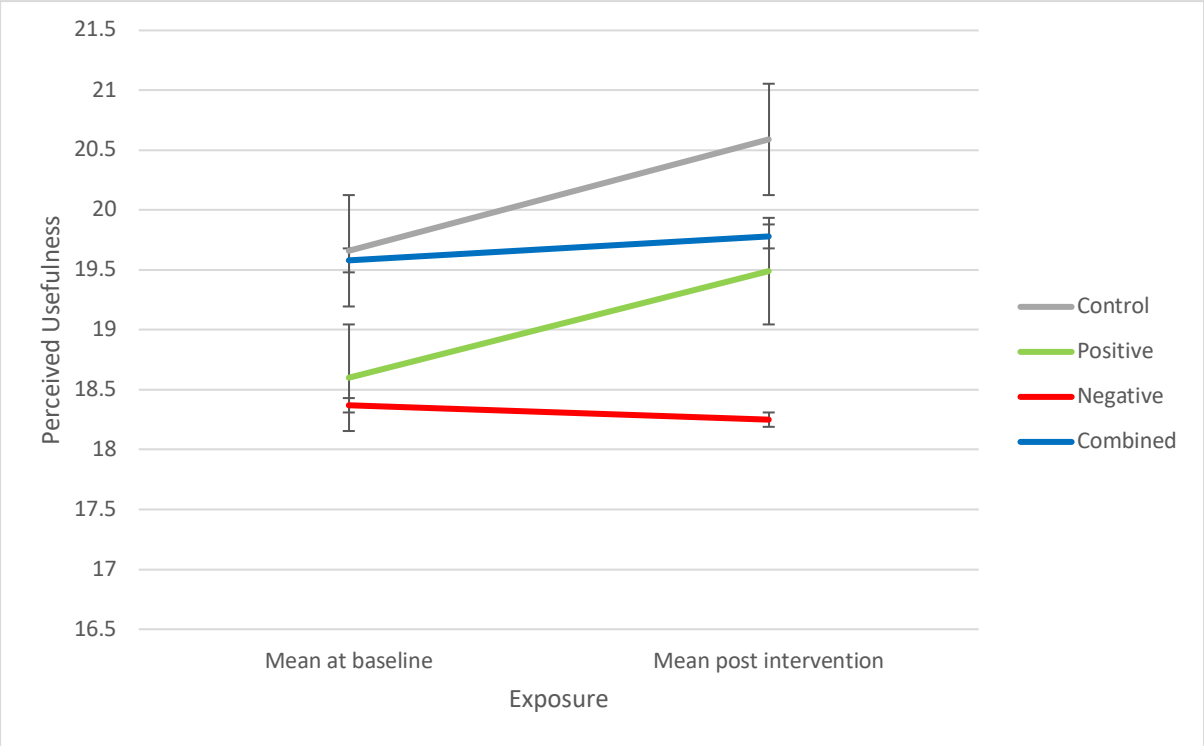


Figure 11: Perceived Usefulness Pre and Post Intervention. Error Bars represent Standard Error.

8.4.3.2.2 Perceived Ease of Use

Table 18: Mean and Standard Deviation for Perceived Ease of Use Pre and Post Intervention

Condition	N	Mean (SD) at baseline*	Mean (SD) post intervention*
Control	79	17.30 (3.14)	18.15 (3.60)
Positive	87	17.55 (2.90)	18.18 (3.36)
Negative	89	16.47 (3.88)	16.93 (4.03)
Combined	86	17.49 (3.33)	17.92 (3.77)
Total	341	17.20 (3.35)	17.78 (3.72)

*MIN score = 5, MAX score = 25

A 2 x 4 mixed ANOVA was conducted to examine the effect of Exposure (within) and Condition (between) on Ease of Use. A significant main effect was found for Exposure, $F(1, 337) = 27.81$, $p < .001$, $\acute{\eta}^2_p = 0.076$, with mean scores showing a significant increase in perceived ease of use from baseline to post intervention across all condition. No significant main effect was found for Condition, $F(3, 337) = 2.23$, $p = .085$, $\omega^2_p = 0.005$. The interaction between Exposure and Condition was also non-significant, $F(3, 337) = 0.72$, $p = .541$, $\omega^2_p = -0.001$.

A repeated measures ANOVA was conducted to examine the change in scores from pre-post exposure. Significant differences were shown for the control condition, $F(1, 78) = 20.694$, $p < .001$, positive condition $F(1, 86) = 10.904$, $p = .001$, negative condition $F(1, 88) = 5.192$, $p = .025$, but not for the combined condition, $F(1, 85) = 2.207$, $p = .141$. Figure 12 shows a visual representation of the control, positive and negative groups having a significant increase in ease-of-use score. Despite the non-significant result, the combined condition also observed a slight increase in scores between pre intervention and post intervention for ease of use. Mean scores are presented in Table 18.

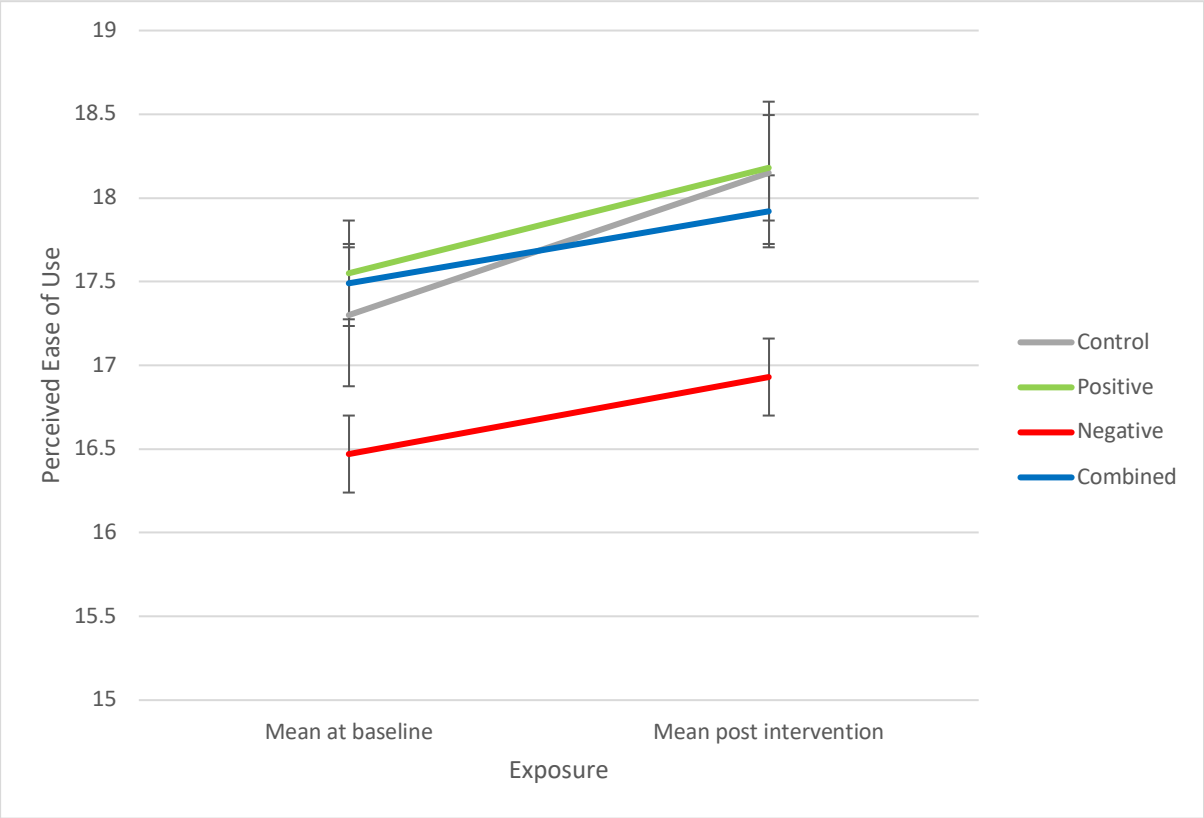


Figure 12: Perceived Ease of Use Pre and Post Intervention. Error Bars represent Standard Error.

8.4.3.2.3 Perception of Data Security

Table 19: Mean and Standard Deviation for Perception of Data Security by Exposure and Condition

Condition	N	Mean (SD) at baseline*	Mean (SD) post intervention*
Control	79	10.08 (3.16)	10.35 (3.21)
Positive	87	9.95 (2.82)	11.83 (2.59)
Negative	89	9.49 (2.95)	5.44 (2.63)

Combined	86	10.16 (2.97)	8.73 (3.51)
Total	341	9.92 (2.97)	9.04 (3.84)

*MIN score = 3, MAX score = 15

As the study aimed to manipulate perceptions of data security, a 2 x 4 mixed ANOVA was conducted to examine the effect of Exposure (pre and post) and Condition (between-subjects) on perception of data security to test whether the stimuli presented in each condition was successful at influencing perceptions of data security. Significant main effects was found for Exposure, $F(1, 337) = 31.12$, $p < .001$, $\acute{\eta}^2_p = 0.085$, and Condition, $F(3, 337) = 28.22$, $p < .001$, $\omega^2_p = 0.107$. There was a significant interaction between exposure and condition, $F(3, 337) = 66.85$, $p < .001$, $\omega^2_p = 0.225$.

To examine the interaction, a one-way ANOVA was conducted to examine the effect of Condition on perceptions of data security, post intervention. A significant main effect was found, $F(3, 337) = 73.10$, $p < .001$, $\omega^2_p = 0.388$. Games-Howell post-hoc analysis indicates a significant difference between the control group and negative condition ($p < .001$), positive condition ($p = .008$), and combined condition ($p = .012$). There were also significant differences between negative and combined group ($p < .001$), negative and positive condition ($p < .001$) and the combined and positive condition ($p < .001$), indicating that overall, the positive condition had more positive perceptions of data security. As shown in Table 19, the mean score for the negative group post intervention was lower compared to the other three conditions, with the positive condition having the highest mean score, post exposure.

A repeated-measures ANOVA was then conducted to examine the effect of exposure on perception of data security. A significant difference between pre and post intervention scores was found for positive condition, $F(1, 86) = 59.20$, $p < .001$, $\acute{\eta}^2_p = 0.408$, negative, $F(1, 88) = 125.99$, $p < .001$, $\acute{\eta}^2_p = 0.589$ and combined group, $F(1, 85) = 13.806$, $p < .001$, $\acute{\eta}^2_p = 0.140$, but not for the control group, $F(1, 78) = 1.65$, $p = .203$, $\acute{\eta}^2_p = 0.021$. A visual representation of the difference between pre intervention and post intervention scores can be seen in Figure 13, whereby the negative condition and combined condition show a significant decrease in score post exposure, the positive group shows a significant increase as a result of the informational stimuli and the control group shows no significant change.

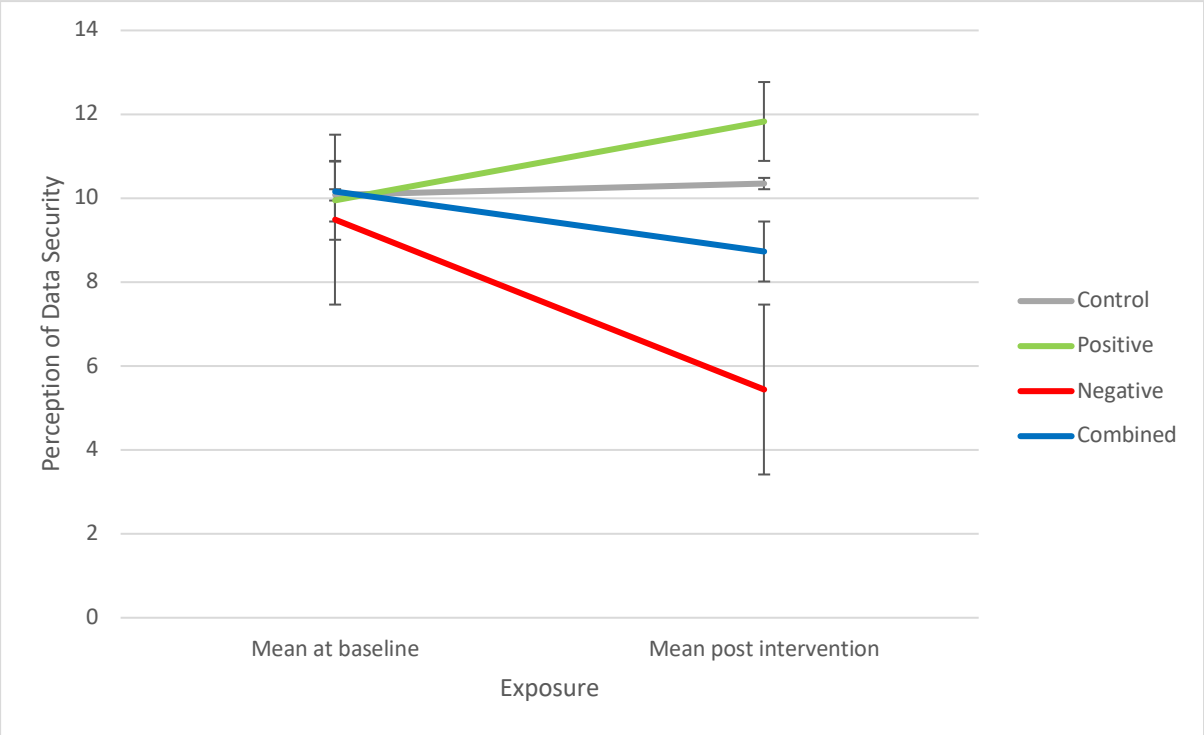


Figure 13: Perception of Data Security Pre and Post Intervention. Error bars represent Standard Error.

8.5 Discussion

This study examined the effect of specifically designed stimuli aiming to change older adult's intentions to use and attitudes towards MMHIs by improving awareness. A second aim of the study was to examine the effect of information about data security on perceived ease of use and perceived usefulness. The results show that while showing participants positive information about data security doesn't improve older adult's intentions to use MMHIs, providing negative data security information reduces participant's intentions to use, along with other secondary outcomes of the TAM such as perceived usefulness, and attitudes. As a result, data security information remains an important determinant of use of MMHIs for older adults.

8.5.1 Intention

Within this study, intention to use MMHIs significantly improved for the control condition and significantly decreased for the negative condition. However, there was not a significant improvement in intention to use in the positive condition. As a result of the change for the negative condition, H1 as stated in the introduction, is supported as data security information reduced intention to use in the negative data security condition.

Despite the positive information about privacy not improving intention to use, there was a significant reduction in intentions to use for the negative data security experimental condition. This provides support for the suggestions presented by O'Loughlin et al., (2019) as it shows the direct negative impact that poor data security practices of health apps have on user's intentions to use, attitudes and how effective they perceive the app to be.

The finding that the control group alone had a significant increase in intention to use highlights the fact that providing general information about MMHIs alone is sufficient in improving intention to use. This finding supports a number of previous studies investigating the effect of providing information on acceptance/intention to use (Apolinário-Hagen, et al., 2018; Ebert et al., 2015). However, the fact that the positive data security condition increased intentions but failed to reach significance indicates that alleviating concerns of data security is not sufficient to improve intentions. While the positive condition received the same general information as the control group, it may be that discussion of data security, a topic that most older adults are not knowledgeable on (Nicholson, Coventry, & Briggs, 2019), and therefore resulted in older adults not wanting to use in the future and so resulted in a non-significant change in scores. Whereby the negative data condition was sufficiently 'bad', which enabled older adults able to see the consequences of this information and resulted in a decrease in intentions to use.

8.5.2 Attitude

Attitudes towards MMHI were altered in this study depending on the experimental condition. Attitudes significantly improved in the positive condition, control condition and the combined condition. While this finding shows that the information about data security leads to improved attitudes, the finding that the control condition and the combined condition also improved attitudes is likely to be a result of the 'general information' provided alongside the information about data security. This shows simply increasing awareness of MMHIs can be an effective strategy of improving determinants of use. This is a particularly pertinent point for older adults who likely have very little awareness of MMHIs, as demonstrated in Chapters 6 and 7. As a result, H2 as described in the introduction, is supported as the information provided successfully altered participants attitudes towards MMHIs.

The association between awareness and attitudes towards mental health therapies has gathered support (Casey & Clough, 2016). Indeed, the results from this study add to this literature. Specifically, the findings add support for the finding that attitudes toward MMHIs can be

improved through the use of informational text (Apolinário-Hagen et al., 2018; Donovan et al., 2015), within an older adult sample.

8.5.3 Perception of Data Security

This chapter describes a study that is among the first exploring the effects of an awareness-based stimuli aiming to improve awareness and alter perceptions of MMHIs. In particular, it is the first to explore the effect of data security information on perceptions of MMHIs within a sample of older adults. Perceptions of data security improved significantly for the positive condition and decreased significantly for the negative condition. In addition, in the condition where both positive and negative information was provided, perceptions of data security significantly decreased, suggesting the negative information was of more importance to the older adult sample. As a result, H3 is supported as the text-based information significantly altered participants perceptions of data security when using an MMHI.

The findings presented support previous literature within this area. In particular, Ebert et al., (2015) is among the only other study to include perceptions of data security within their AFI. They found that an AFI delivered through a video was successful at addressing concerns regarding data security. The current study builds on this evidence by actively addressing concerns of data security within the positive condition and adding to concerns within the negative condition. As a result, changes in intentions, attitudes, perceived usefulness and perceived ease of use have been affected. This supports the conclusion of Ebert et al., (2015), in that proactively addressing drivers of acceptance can reduce misconceptions and consequently increase acceptance of AFIs.

8.5.4 Perceived Usefulness

Perceived usefulness of MMHIs were manipulated by the stimuli presented in this study. In the positive condition and control condition, significant increases in perceived usefulness were observed, supporting H4. However, for the negative and combined condition, there were non-significant changes in perceived usefulness scores.

This finding is likely to be explained by the fact the positive condition and control condition experienced an absence of 'negative' information, which may have influenced their perceptions of usefulness of MMHIs. Whereas the negative condition and combined condition both were exposed to negative data security information. This finding is prominent as it suggests that for

older adults, the perceived usefulness of a mental health intervention is associated with the data security practices of a particular intervention.

This finding supports literature that have adopted the UTAUT model to guide AFIs. For example, Baumeister et al., (2014) found improvements in performance expectancy as a result of a standardised personal information session from an expert, however the difference failed to reach significance. Furthermore, Apolinário-Hagen et al., (2018) significantly improved perceptions of usefulness as a result of text based intervention. However, this result contrasts Lin, Faust, Ebert, Krämer, and Baumeister, (2018) who did not see a significant effect of performance expectancy as a result of their AFI.

8.5.5 Perceived Ease of Use

Perceptions of ease of use changed significantly between pre intervention exposure and post intervention exposure scores. For the positive condition, negative condition and control condition, there were significant increases in perceived ease of use scores, providing support for H5. However, for the combined condition, there was not a significant difference in scores.

While significant differences were found for ease of use in the positive, negative and control condition for this study, Baumeister et al., (2014) found results in favour of the intervention group for their AFI but as with perceived usefulness, this failed to reach significance. Additionally, while guided by the UTAUT model, Lin et al., (2018) also failed to improve effort expectancy within their study which the authors attribute to the fact that participants had high baseline level of acceptance within their sample. Alternatively, Baumeister et al., (2020) were able to successfully improve the effort expectancy scores in a sample of psychotherapists, with a small to medium effect.

In addition, the control group alone provides useful insights for the implementation of MMHIs within the older adult age group. For general attitudes, perceived usefulness, perceived ease of use and intention to use the control group showed a significant increase in scores as a result of receiving general information about MMHIs. This supports a number of existing studies that support the assumption that improving awareness can lead to improvements in determinants of use (Apolinário-Hagen et al., 2018; Baumeister et al., 2014; Donovan et al., 2015; Ebert et al., 2015; Lin et al., 2018).

The design of the intervention in this study is also an important factor to consider. As previous literature has emerged from other countries, this study is the first study in the UK to develop

an AFI using the NHS website, a trusted provider of health care in the UK. While previous literature has aimed to examine the most effective mode of delivery looking at different methods of delivery (e.g. text vs video) (Casey et al., 2013) and different people delivering the message (e.g. expert opinion vs user testimonial) (Apolinário-Hagen et al., 2018), the current study adds to this literature by considering the role text based information delivered through an NHS website. While it is unclear how this method of delivery compares to previous literature due to the absence of comparisons, the results demonstrate that this method of information delivery for older adults is successful in shaping perceptions of MMHIs for older adults.

8.5.6 Limitations

While this study has a number of methodological strengths, limitations must also be considered. Participants for this study were recruited through Prolific which is an online recruitment platform. Therefore, as with other studies in this thesis, it is likely that the participants already had fairly high intentions to use and an understanding of data security concepts and so the information provided may not have had a profound impact. Future research should explore alternative recruitment methods and venues of recruitment of older adults to strive for a sample of older adults that is more representative. For example, recruitment from clinics, churches and community groups.

Furthermore, while the aim of the study was to improve perceptions of MMHIs within a general sample of older adults, a measure of depressive symptoms was not taken, nor was it a requirement of participation to experience symptoms of depression. Therefore, the findings cannot be generalised to older adults who are already seeking treatment for depression or are experiencing depressive symptoms. While chapter 6 did not find support for the hypothesis that symptoms influence attitudes towards MMHIs for older adults, this is a finding of previous literature and so the potential generalisability issues should be acknowledged.

Finally, while intention to use is the best proximal predictor of actual use, it does not always translate into behaviour (known as the intention-behaviour gap; Bhattacherjee & Sanford, 2009). As a result, it is difficult to conclude whether AFIs lead to increased uptake. While this is a limitation shared by the study presented in this chapter, it has been suggested that future research should incorporate ‘actual use’ of MMHIs as an outcome measure (Baumeister et al., 2014) as seen in Lin, Faust, Ebert, Krämer, and Baumeister, (2018). Additionally, evidence suggests that the intention-behaviour gap is moderated by the strength of attitudes, and so the

fact that this study was able to successfully improve attitudes towards MMHIs may go some way to reducing this gap (Bhattacherjee & Sanford, 2009).

8.6 Conclusion

This study aimed to test the extended TAM model presented in chapter 7, using an experimental design. The study explored the role of perception of data security and whether alleviating or accelerating these concerns would lead to differences in determinants of use of MMHIs. Text based stimuli were created which aimed to directly assess the role of data security perceptions in uptake of MMMHIs based on the findings from study 1, 2 and 3. An NHS website design/mock-up was used to deliver the information as this was seen as a trustworthy provider of information by participants in study 1. It was found that the information provided was able to alter perceptions of MMHIs through determinant factors of technology acceptance, as guided by the Technology Acceptance Model.

Chapter 9: General Discussion

9.1 Introduction

This discussion considers the overall findings of the four studies presented within this thesis and considers the implications of these findings. The chapter will start by revisiting the research objectives presented in chapter 1 and outline the key findings from the four studies presented in this thesis. Finally, consideration is given to the implications of these findings. Specifically, consideration is given to how the findings from this thesis may have implications for mental healthcare delivery, theory and the design of MMHIs. Finally, this chapter will outline limitations of the thesis before suggesting avenues of future research.

9.2 Research Objectives

At the beginning of this thesis, it was identified that there was very little consideration of mobile mental health interventions for older adults. Where research had included older adults in the sample, the sample size of older adults was low with no consideration given to the specific needs of older adults. To address these gaps in the literature, this thesis devised three research objectives:

1. Identify factors that are associated with use of MMHIs for older adults (Study 1, 2)
2. Examine how identified predictors of older adult's attitudes towards MMHIs relate to intentions to use, using existing technology acceptance theory (Study 3)
3. Explore whether perceptions of MMHIs can be changed in older adults (Study 4)

These research objectives were addressed with four research studies presented in this thesis. As a result of the four studies, older adult's perceptions of data security, effort expectancy and awareness of MMHIs were identified as key factors that may lead to future use of MMHIs for older adults.

9.3 Summary of Findings

Although existing literature alluded to the barriers that may exist in the uptake of MMHIs among a general population, inclusion of older adults was scarce. Additionally, it was highlighted in chapters 2 and 4 that older adults engage with technology differently to other age groups and may therefore have different factors that hinder use of MMHIs. As a result, current assumptions could not be generalised to the older adult age group. This led to the

completion of four studies presented in this thesis, starting with a qualitative study which bridged this gap in research by identifying hindering factors of MMHI use with a focus on older adults by exploring the research question: What are the barriers that older adults with access to technology face in the uptake of mobile mental health interventions? The findings of this study led to further research questions examined by the following three studies, which are summarised below:

Table 20: Summary of Main Findings

Study	Main Findings
1	• Barriers were identified across all levels of the social ecological model, most notably at the individual level. • Despite participants owning relevant technologies and possessing technological skills, concerns were highlighted over the use of technology and lack of face-to-face interaction. • The demonstration of available MMHIs to older adults is a novel, yet valuable, approach to improving the validity of findings when investigating barriers to MMHIs for older adults.
2	• Perceptions of data security, effort expectancy and awareness of MMHIs were significant predictors of attitudes towards MMHIs. • Awareness of MMHIs is low in older adult samples. • The APOI is a good measure of attitudes towards MMHIs in older adults and hold comparable internal reliability to the original scale.
3	• An adapted Technology Acceptance Model with the inclusion of perceptions of data security significantly predicts older adults' intentions to use MMHIs and attitudes towards MMHIs. • The model presented has good model fit using indices required for Structural Equation Modelling.
4	• Acceptance Facilitating Interventions can be successful in altering perceptions of MMHIs in older adults. • Perceptions of data security are an important consideration for older adults and can directly influence their intention to use (or not use) MMHIs. • Providing trusted information through the NHS about MMHIs may be a method to improve overall intentions to use among older adults.

9.3.1 Study 1

Semi-structured interviews were conducted with ten retired older adults, all over 50 years of age with the interview transcripts analysed using thematic analysis. Overall, the study

identified six key themes, or barriers, that are prevalent factors for the older adults included in the sample: mental e-health awareness, interaction with technology, discontinuation, 'seeing' facilitates therapeutic alliance, incongruent role of the GP, and privacy and confidentiality. This study used the Social Ecological Model (Stokols, 1996) as an organising framework to contextualise the identified barriers and delineate each barriers role within the wider society. Although barriers to MMHI use were found across a variety of levels of the Social Ecological Model, barriers were most profound at the individual level with intrapersonal factors having a large impact. Largely attributable to the awareness of MMHIs, concerns over technology use and reasons for discontinuation of use such as the perceived effort and perceived utility of MMHIs presented as important barriers to MMHI use. This study contributed to existing literature as it was the first to specifically explore barriers to MMHI use for older adults. While some barriers supported previous literature (e.g. technical issues, awareness), others were unique perceptions of older adults, such as the 'incongruence of GP' which captured older adults' conflicting views toward the role the GP has in their mental health care. This study was also novel in its approach as it demonstrated popular apps to participants as part of the interview schedule to ensure older adults knew what MMHIs were and to aid older adults in their appraisal of such smartphone apps.

9.3.2 Study 2

Having identified a number of factors that hindered older adult's use of MMHIs in chapter 5 (study 1), chapter 6 (study 2) was a quantitative study (cross-sectional survey) which aimed to identify determinants of older adults' attitudes toward MMHIs and explore how the identified barriers were associated with attitudes towards MMHIs. In this study, attitudes were measured using the Attitudes toward Psychological Online Intervention (APOI) (Schröder et al., 2015) scale, which consisted of four dimensions of attitudes; confidence in effectiveness, technologisation threat, anonymity benefits and scepticism. Informed by the identified barriers by older adults in study 1 and with the consideration of additional factors from relevant literature outlined within the chapter, an online survey was completed by 298 retired older adults, over 50 years of age. Awareness of MMHIs was found to be low in this sample of older adults, providing support for some of the findings from study 1. Perceptions of data security, perceptions of how much effort was required to use an MMHI (effort expectancy) and participant's awareness of MMHIs (e-awareness) were significant predictors of attitudes toward MMHI use.

9.3.3 Study 3

While loosely guided by the Technology Acceptance Model (TAM) (Davis, 1986) chapters 5 and 6 (study 1 and 2) were exploratory in their approach as little existing literature addressed factors associated with older adult use of MMHIs. Following criticisms of existing health technology research that research was not aligned with suitable theory (Gammon et al., 2008; Peek et al., 2014), the next step in this thesis, chapter 7 (study 3) modelled acceptance of MMHIs using structural equation modelling using the TAM factors, along with additional factors confirmed to predict attitudes in study 2. Therefore, this chapter presents an adapted TAM that was specifically developed within the context of acceptance of MMHIs for older adults. Three-hundred and twenty-one retired older adults completed an online survey comprised of scales measuring TAM variables including perceived usefulness, perceived ease of use, attitudes and intention to use, along with perceptions of data security and e-awareness as these two variables were identified in chapter 6 as significant predictors of attitudes towards MMHIs. The final model demonstrated associations between perceived usefulness, perceived ease of use, and perceptions of data security and attitudes towards MMHIs in relation to intentions to use. The relationships were significant in the hypothesised directions whereby higher perceptions of usefulness and ease of use led to more positive attitudes and higher intentions to use. Also, as suggested by study 2, and confirmed in study 3, higher perceptions of data security also led to positive attitudes and higher intentions to use. These findings support the existing TAM model (Davis, 1986) and this study presents an adapted model of TAM which provides evidence for the role of perceptions of data security in the formation of attitudes and older adult's intentions to use MMHIs.

9.3.4 Study 4

Building on these findings, chapter 8 (study 4) aimed to empirically study whether manipulating information provided about data security of MMHIs leads to changes in intentions to use, along with other determinants of use, as suggested by the TAM. The manipulation of perception of data security was a result of the culmination of previous studies presented in this thesis whereby perception of data security was identified as a concern in the qualitative study, a significant predictor of MMHI related attitudes, and was a significant addition to the structural model in study 3. This final study developed, and piloted novel experimental stimuli with design based on an NHS webpage to deliver the information to older adults through an online survey that incorporated an experimental paradigm. Participants (341

retired older adults) received general information about MMHIs and were randomised into one of four groups which determined the type of data security information they received: positive data security information, negative data security information, a combination of both positive and negative data security information and a control group which received no information about data security. The results showed a significant increase in intentions to use in the control group and a significant reduction in the group that received negative information. While the group that received positive information about data security demonstrated an improvement in MMHI-related attitudes, perceived usefulness and perceived ease of use, no significant improvement in intention to use were observed. Conversely, the group that received negative information about data security consistently reported decreased scores across intentions to use, perception of data security, attitudes towards MMHIs and increased for the perceived ease of use condition. Overall, these findings suggest that perceptions of data security are an important consideration for the uptake of MMHIs for older adults, and that providing information about how data is kept secure improves determinants of use identified by the TAM, while informing older adults about the poor data security practices of some MMHIs leads to significant reductions in intentions to use MMHIs, along with other determinants of use. In light of these findings, there are a number of implications which will be considered in the next section.

While these findings are important, this thesis also affords more specific implications for theory, design of mobile mental health interventions targeted at older adults and mental healthcare delivery for older adults which will now be discussed. Finally, as the fourth study in this thesis was conducted within the first COVID-19 lockdown, consideration is also given as to how these findings may impact on the use of MMHIs for older adults within a pandemic.

9.4 Implications for Theory

From a theoretical perspective, chapter 6 (study 3) was among the first to apply Structural Equation Modelling analysis in the context of MMHIs acceptance with a sample of older adults. With the proposed extension of the TAM model including participant's perceptions of data security, the data was able to predict 72% of the variance in attitudes and 62% of the variance in intention to use. This is comparable to studies that have used the TAM in a health context. For example, a study that utilised SEM to investigate adoption of e-health in developing countries was able to explain 63% of variance in intention to use, with the additions of privacy and trust to the original TAM model (Hoque, Bao, & Sorwar, 2016). This is also very comparable to other TAM studies that have been conducted in healthcare contexts with

variance explained of intention to use typically ranging between 50% and 70% (Holden & Karsh, 2010).

This thesis also provided some theoretical clarity to the existing research on MMHI acceptance. A number of studies have recently been interested in looking at the determinants of attitudes. However, these studies have measured attitudes using surrogate measures such as 'perceived usefulness and helpfulness' (Apolinário-Hagen, et al., 2018). Theoretical literature states that attitudes and perceived usefulness are two distinct factors (Davis, 1986). The study presented in chapter 6 has therefore adopted the TAM to investigate each of these distinctive variables to determine more conclusively their influence on overall intention to use MMHIs.

Furthermore, while other theoretical extensions of the original TAM model, such as TAM2 (Venkatesh & Davis, 2000) and TAM3 (Venkatesh & Bala, 2008) did not include attitudes due to poor predictive power (Venkatesh & Davis, 2000), research suggests that attitudes are often overlooked in technology acceptance literature (Yang & Yoo, 2004) and are an important determinant of technology acceptance (Dwivedi et al., 2019; Guo, Han, Zhang, Dang, & Chen, 2015). Attitudes have been the centre of literature investigating MMHI acceptance and there is an emerging wealth of support of their influence in the uptake of MMHIs (Apolinário-Hagen et al., 2019; Apolinário-Hagen et al., 2017). As attitudes in study 3 were integral to predicting intention to use and therefore suggest that attitudes towards MMHI remain a key implication. Throughout the model tested in this thesis, which was based on the TAM, attitudes significantly predicted intentions to use and was an important mediator between the predictors and also intentions to use. As a result, the role of attitudes is clear and thus it is essential that service providers and researchers continue to investigate ways in which positive attitudes can be promoted.

Chapter 5 (study 2) also contributes to the wider literature in a number of ways. Firstly, it identifies three predictors of older adult's attitudes towards MMHIs, whereby attitudes were measured by the APOI scale (Schröder et al., 2015). This is the first study to apply the APOI scale within an older adult sample, and found comparable psychometric properties (Cronbach's alpha) within the older adult sample to the younger sample included in the scale development (Schröder et al., 2015). While a number of other scales have been developed since this study was conducted to measure older adult's attitudes towards MMHIs, such as the Working Alliance Inventory for Internet Interventions (WAI-I) (Martín et al., 2019), and the e-Therapy Attitudes Measure (Clough, Eigeland, Madden, Rowland, & Casey, 2019), the APOI remains

a robust scale for this thesis due to the fact it's subscales represent a number of dimensions that were raised in the first qualitative study. Additionally, while Chapters 6 and 7 (studies 3 and 4) utilised a separate attitudes scale which was more theoretically appropriate for the structural equation modelling analysis and for the experimental study, this thesis benefits from the fact that it makes use of both a theoretically suitable attitudes scale, along with a scale that is designed to specifically measure acceptance of digital interventions through its dimensions of attitudes. This approach is viewed favourably by Hennemann, Beutel, and Zwerenz, (2016) and they call for future research to use such scales in a variety of different contexts.

9.5 Implications for Design of MMHIs

The findings from this thesis also provide implications for the design of MMHIs. For example, perception of data security was identified as a barrier in the qualitative study (study 1) and was also confirmed as an important determinant of attitudes towards MMHIs in study 2 and intentions to use in study 3. In order to alleviate these concerns, designers of MMHIs may ensure that privacy policies clearly outline how users data is being stored and used and those hosting the service must be mindful that media reports of privacy breaches of health data in general, and mobile apps in particular may affect perception of data security. Research suggests that this currently is not being achieved, with only a quarter of apps aimed at supporting people with bipolar disorder providing a privacy policy for users, demonstrating a significant lack of transparency with reporting how data is used in mental health apps (Nicholas, Larsen, Proudfoot, & Christensen, 2015). Secondly, relevant design features should be put in place to protect the information that older users may share with the apps. Proudfoot et al., (2010) found that 93.7% of participants indicated they would want a username and password to log on – this was considered to be mandatory in their study and may also be an attractive feature for older adults who engage with this method of self-help.

Furthermore, research suggests that only 8% of health interventions consider the needs of older adults in the design and development of interventions (Wasilewski, Stinson, & Cameron, 2017). These findings imply that it might be important to consider the learning needs of older adults in the design and development phases of mobile interventions to improve perceived ease of use (Seifert, Reinwand, & Schlomann, 2019).

Additionally, in a sample of older adults who self-identify as technology users, concerns over technological skills and how easy to use and the accessibility of MMHIs are still prevalent in the findings from this thesis, with results showing that perceived ease of use was significantly

associated with attitudes towards MMHIs and intentions to use. This is a key finding of this thesis and has clear design implications.

When considering the design implications of perceived ease of use of MMHIs for older adults, consideration must be given to Seifert et al., (2019) who specifically address the designing of digital mental health interventions for older adults. The authors observe that older adults use technology selectively and in unexpected ways and therefore call for a focus on designs that are tailored to older adults in such a way that can encourage trust and facilitate use. Given the importance of perceived ease of use in the formation of attitudes and intention to use MMHIs for older adults, as found in this thesis, designs should be intuitive, self-explanatory, transparent and consistent with navigation within the app to be consistent and logical to facilitate ease of use (Seifert et al., 2019).

Additional suggestions to improve ease of use include: providing on-going technical support and technical training (Lee & Coughlin, 2015; Parker et al., 2013) and by ensuring MMHIs have attractive interfaces (Tractinsky et al., 2000). In order to achieve this, the role of user centred design is recognised in this process (Seifert et al., 2019). For example, Mohr, Weingardt, Reddy, and Schueller, (2017) identify that the majority of design has been top down and the research to date has not done an efficient job at procuring input from patients and potential users. Consequently, the needs, goals, limitations, capabilities and preferences of all stakeholders goes largely unnoticed. As a result, rather than focusing on RCTs to gather evidence for the efficacy of such interventions, they recommend a new focus on designing the interventions for the users and as a result, efficacy and acceptability will come naturally. This will also ensure that concerns of privacy, ease of use, accessibility of privacy policies etc. are captured at design phase and concerns are addressed early in the design process.

9.6 Implications for Mental Health Practice

The way in which the findings of this thesis may have implications for the delivery of mobile mental health care for older adults are also important to consider. A key finding of this thesis is the importance placed on perception of data security of MMHIs in older adults' attitudes towards MMHIs and how likely they are to use them. This was a consistent finding throughout all four studies, with the negative data security condition in chapter 7 (study 4) causing a large reduction in older adult's intentions to use MMHIs. As a result, it can be concluded that the data sharing practices of some apps potentially have harmful implications for the widespread adoption of MMHI. Because perceptions of data security have been identified as a barrier for

younger age groups (Stiles-Shields et al., 2017; Wilkowska & Ziefle, 2011), we may expect to observe similar findings should this study be replicated among younger people. Consequently, we can infer that if the findings from reviews into the privacy policies of apps are widely advertised and become widely known facts, it is likely to have an overall negative impact on adoption and use (O'Loughlin et al., 2019).

These findings set the groundwork to prompt future research studies, in the older adults and MMHI research space, which are required to move towards increased guidance for older users and to ensure apps have adequate privacy policies. As highlighted by O'Loughlin et al (2019), only 4% of reviewed apps had privacy policies providing sufficient information regarding data handling procedures. This thesis provides further evidence to attest to the importance of privacy policies and the requirement to ensure they are fit for purpose should remain a focus (Hill, Creswell, Vigerland, Nauta, & March, 2018). It is also important to ensure that policies and practices are communicated clearly to older adults, taking into account their requirement for clear information with key details made accessible. Additionally, there is a need for wider regulation and reviews within the apps that are released, with researchers already reporting that data security measures should be included in the NHS's evaluation of digital therapies (Bennion et al., 2017). Clearly, older adults value the privacy of their information and this thesis provides strong support for the role of privacy security perceptions in the uptake of MMHIs. Of course, it may be that the perceived harms outweigh the benefits for older adults and that until data security practices are improved, and data sharing is more transparent, the majority of older adults may choose not to use MMHIs regardless of how much they are needed, how well they work or how accessible they are.

Importantly, the studies conducted within this thesis included older adults who already owned suitable technology and were willing to participate in research looking at adoption of MMHIs in older adults, and therefore were interested in the topic. In a number of studies presented in this thesis, attitudes were fairly positive, and in the qualitative study participants often made positive remarks towards the use of technology to deliver mental health care. While this suggests a bias (discussed below), rather than assuming MMHIs are unsuitable for all older adults, it indicates that healthcare professionals and other healthcare services should instead look for individuals for whom MMHIs may be suitable, and provide support in accessing these services (Crabb et al., 2012). It is acknowledged that MMHIs may not, and may never will be, able to address the mental health needs of all older adults. However, this does not mean that those older adults who are interested and capable of using them should miss out on an

opportunity to access additional mental health support. Despite the qualitative study highlighting a preference for face-to-face delivery of mental health care, the increased technology use and computer literacy of older adults means that a large number of older adults could benefit from MMHIs.

It was found within this thesis that although the sample consisted of older adults who use technology, concerns still arose with regard to technological skills following a demonstration of three key apps listed on the NHS choices website for mental health apps. Therefore, it behoves intervention providers to ensure that older adults are given a thorough demonstration of the intervention at uptake, but are also provided with technical support throughout engagement with the intervention to ensure continued use. Crabb et al., (2012) recommend a demonstration of the intervention for older adults to provide technical and clinical support – this would also provide older adults with an opportunity to ask questions and ensure they have enough technical knowledge to start using the intervention. This is supported by the findings from the thesis as participants reported positive effects from the demonstrations of available apps. Technical training also improves older adult's self-efficacy in using computers and technology which is a promising way to overcome this barrier (Kuerbis et al., 2017).

A further important finding from this thesis is that awareness of MMHIs is low in older adult populations. This was a consistent finding throughout the thesis with it being a key theme in the 'individual' section of the social ecological model in chapter 4 (study 1) and was a consideration in study 2. Additionally, e-awareness could not be included in the structural equation model due to the high kurtosis on this measure. This was due to the fact that the majority of participants scored very low on the e-awareness scale. This is an important consideration as it has been recognised in previous research that negative beliefs towards MMHIs are reduced in accordance with self-reported familiarity (Handley et al., 2015). As a result, it is likely that the effects of an aforementioned demonstration of the intervention prior to use will increase familiarity and therefore improve perceptions of the intervention.

Similarly, the finding in relation to 'negative attitudes towards apps' presented in the qualitative chapter is important in two ways. Firstly, it highlights that older adults may have different attitudes towards apps in general and mental health apps specifically. Secondly, this finding poses questions with regard to raising awareness of these apps. For example, if older adults are not browsing the apps store there is no opportunity for them to find these apps by themselves. This raises questions of where it might be best to signpost these interventions to

older adults so as to increase their visibility and improve older adult's awareness of them to ultimately trigger uptake. While this thesis explored the use of an NHS-webpage design to increase awareness, consideration should also be given to none-digital forms of signposting such as the use of flyers, posters and word of mouth. Fox and Connolly, (2018) recommend the provision of flyers to health professionals who are trusted influencers and the first point of communication for a number of patients, which is supported by the findings of this thesis. This may aid in the transfer of information about MMHIs in general but may also assist in the translation of information regarding security and privacy of information, ensuring that information is translated to older adults in a familiar and digestible format.

It is demonstrated within this thesis that providing specific information to older adults to improve awareness and knowledge of MMHIs can alter their perceptions of such interventions which leads to an increase in intentions to use and attitudes. Namely, the control condition, wherein participants received general information about MMHIs providing information about the usefulness and accessibility of them, was able to significantly improve older adult's intentions to use. This suggests that this approach may be considered for use by the NHS nationally to improve awareness for older adults who are searching the internet for information surround mental health help. While this has already been done to some extent within the NHS (e.g. https://www.lpft.nhs.uk/steps2change/how-we-can-help/computerised-cbt) this is a local NHS Foundation Trust (Lincolnshire Partnership) and so is not accessible to all older adults across the UK. Additionally, this website is not optimised for older adults and uses a variety of terms they may not understand (e.g. cCBT). As a result, further research is required to investigate the best ways to signpost older adults to this option of mental health care and improve their awareness of mobile mental health interventions.

Furthermore, trust was a prevailing issue at all levels of the social ecological model and remains an important factor in the uptake of MMHIs. An absence of trust in MMHIs, or the information that is being provided from the intervention, also highlights a need for increased education in older adults to outline: how these apps work, the science behind them, and how they change cognition. It does, however, demonstrate that older adults are able to appraise and evaluate the content of these interventions – even if based off a faulty perception of them. The ability to appraise and evaluate interventions is a key aspect to e-health literacy (Norman & Skinner, 2006b), however if appraisal is based on incorrect or lack of knowledge, it can lead to inaccurate conclusions to be drawn by older adults which may affect their willingness to use such technologies.

The notion of trust can also be linked with the perception of data security. If older adults believe the digital system has a strong level of security, then they are more likely to trust it. However, as older adults are generally distrusting of technology (Knowles & Hanson, 2018), in order to believe that the system has a strong level of security then older adults will need to be informed about the data security practices of an app which will then inform their level of trust. The complexities of cybersecurity information seeking in older adults is explored by Nicholson et al., (2019) who also highlight the importance of trusted information sources for older adults, such as professionals.

Trust was also a prevalent topic for older adults when discussing ways of signposting to MMHIs. Trusted facilitators such as GPs and the NHS more generally were identified as trusted sources of information and therefore, it is specifically GPs who may take on the role as 'trusted facilitators' within primary care services, which is pragmatic given that GPs are often the first point of contact for older adults, and because trust in the GP increases with age (Croker et al., 2013). As seen in the initial qualitative study, older adults may place added value on the advice of their GP for mental health related issues – specifically for digital mental health interventions, as older adults have a significant gap in knowledge and awareness of mobile-based interventions, and so may rely on the expertise of their GP to fill this gap for them.

However, in chapter 2, it was identified that GPs act as a 'gatekeeper' for mental health care and are at the centre of a number of reasons as to why they do not receive mental health support. Given the findings from the first study within this thesis, it is clear that older adults place great importance on their GP, despite their attitudes and (in)action of the GP in referring older adults to mental health services (Berry et al., 2019). As a result, this thesis presents clear implications for healthcare practitioners and their role in the delivery such interventions. Indeed, the role of healthcare professionals in the uptake of evidence based MMHIs has been recognised, with studies examining mental health worker's attitudes towards MMHIs. Findings indicate that mental health workers have negative attitudes towards digital delivery of interventions for depression, with their attitudes also being negative compared to individuals suffering from depression symptoms, which may go some way to explaining why implementation has been so slow (Schröder et al., 2017). Having recognised this barrier to largescale uptake, a number of studies aiming to actively improve acceptance among health care professionals such as GPs and psychotherapists through educational stimuli similar in design as the one presented in this thesis with promising results (Baumeister et al., 2020; Donovan et al., 2015).

Despite the perceived incongruence in the role the GP should have in the uptake of MMHIs for older adults, there may be scope for media, charities, voluntary sectors, ads in clinics, organisations and websites to also play a role in raising awareness of these interventions among older adults (Marks & Cavanagh, 2009). Collectively, these sources could provide older adults with a wealth of 'trusted facilitators' of MMHIs which will help raise awareness of their existence. With reference to public health literature, the notion of relying on trusted facilitators reflects 'social prescribing', whereby third sector organisations bridge the gap and support primary care services through signposting and support (South, Higgins, Woodall, & White, 2008). However, further research is required in this respect to ascertain whether older adults see these roles as 'trusted sources'.

This thesis suggests that healthcare professionals in primary care will have some involvement in the uptake of MMHIs for older adults as they are trusted and an accessible source of support, the NHS have suggested that 'self-referral' to psychological therapies is a part of their long-term plan to "improve how people with common mental health problems locate and access treatment" (NHS England, 2017; P25). While this will minimise the role healthcare professionals have in the referral of older adults to mental health services, it is important to ensure that older adults are firstly aware of these services and secondly, able to use them adequately to ensure proficient referral to suitable services. If this represents the future of mental health referral, older adults may remain at the forefront of consideration alongside younger age groups to bolster access, with alternatives considered for those who it may not work adequately for.

The results from the qualitative study also show that participants felt as though delivering mental health care through the medium of technology detracted from the therapeutic process and could result in a reduced effectiveness of the mental health intervention. Resultantly, if older adults feel as though mobile-based interventions provide poorer quality of mental health care, they are less likely to use them. This resonates with the 'perceived usefulness' factor in the TAM (Davis, 1986) and given the role perceived usefulness plays in the formation of attitudes and intentions to use, demonstrated in chapter 6 (study 3), it should be considered in future research.

9.7 Implications for MMHIs in the Context of a Pandemic

As study 4 was conducted through the first COVID-19 lockdown in the UK, it is also pertinent to consider how these findings may impact on the COVID-19 response of older adults. Through

the national lockdowns, older adults, identified as those 50+, have been identified as a 'vulnerable' group of citizens due to their weaker immune symptoms, and increased risk of comorbid health conditions (Centers for Disease Control and Prevention, 2020). As a result of restrictions on meeting face-to-face and socialising, there is an increased focus on technology as older adults are especially vulnerable to loneliness, social isolation and subsequent depression (Gould & Hantke, 2020). Of course, older adults who are 'shielding' are disproportionately affected by COVID-19 as the majority of their social connections is outside of the home. As a result, the national lockdowns are likely to exacerbate loneliness and in turn, increase risk of depression and other mental health symptoms (Armitage & Nellums, 2020). In a world where participation in society is reliant on technology use, we must maintain that older adults remain included and be mindful not to perpetuate ageism (Seifert, 2020). As a result, many health care services made the transition to digital delivery and so it is more important now, more than ever, to ensure that the risk of social exclusion of older adults is minimised, and services are provided with older adults in mind (Seifert, 2020).

Indeed, as many mental health services have transitioned to online platforms, it is now the case that in order to access any mental health care at all, there is a requirement to engage in digital delivery of mental health services. As a result of this, it is likely that the implementation of digital services will be accelerated as a result of the pandemic. However, despite claims that approaches such as self-help apps, remote video or phone conferencing used to fill the gaps in face-to-face delivery may not be suitable for older people or people of lower social economic status (Moreno et al., 2020), the results of this thesis are timely in their insights into how to improve uptake of mobile mental health services and place increased importance on the needs of older adults. The considerations of this thesis are vital to ensure that older adults are prevented from being excluded from society, but also to ensure continued access to vital mental health care throughout the pandemic.

What this thesis therefore highlights, is that a holistic approach is needed in attempts to improve older adults' use of MMHIs, with the implications highlighted in this section affecting a large number of stakeholders. Healthcare and mental healthcare workers need to recognise their biases towards referral to mental health treatments, and recognise older adults are potential users of digital mental health care delivery. Designers and app developers need to be more mindful of the requirements of older adults and incorporate these adjustments into the design of apps. Alternatively, apps need to be created specifically for older adults with participatory design practices in the forefront of app development. Additionally, a recognition of the

interplay between factors is also required by all stakeholders. This thesis has shown that perceived usefulness, perceived ease of use, attitudes, perception of data security, trust among other factors all play a vital role in the formation of perceptions and in older adult's appraisal of apps. Additionally, it is likely that each factor influences one another. For example, older adults are more likely to trust a mental health app if they believe it to be useful, have positive perceptions of data security, it was recommended by a GP and has been designed specifically for ease of use by older adults. Therefore, the focus on one singular aspect may not be enough to persuade older adults to use such intervention. Put another way, older adults may see the utility of such service, but not trust the privacy practices. Equally, they may understand the app to have strong data security practices but see little evidence of the utility of such intervention.

9.8 Methodological Strengths

This thesis also highlights the value in a mixed-methods approach to researching the uptake of MMHIs for older adults. While this area is dominated with quantitative studies investigating efficacy, acceptance and app features, among other things, it is important to consider the voice of older adults, and to ensure their views, opinions and ideas are heard. The qualitative component to this thesis provided invaluable insights into older adult's perceptions of MMHIs which sometimes challenged assumptions. As a result of this approach, this thesis was able to focus on the actual barriers that older adults experienced in the uptake of MMHIs, rather than assumed barriers from previous literature. Additionally, the use of quantitative surveys allowed for the investigation of the qualitative findings within an increased sample size and more diverse sample which was advantageous as it provided support for the qualitative findings and allowed for statistical testing when identifying significant determinants of attitudes towards MMHIs and lead to robust analysis of the adapted TAM model in chapter 6 (study 3). Finally, the use of an experimental study allowed for the testing of important factors identified within the thesis. Consequently, the thesis was able to utilise a combination of methodologies which results in a more detailed picture of the factors associated with MMHI use in older adults.

9.8.1 Development of Novel Acceptance Facilitating Stimuli

Study 4 was an experimental study which aimed to improve determinants of use of MMHIs within a sample of older adults. In order to achieve this, an Acceptance Facilitating Intervention (AFI) was developed, guided by theory and previous literature. While existing literature had examined AFIs within a number of different contexts, with a number of different mediums of stimuli delivery, this study aimed to examine the effect information about data security would

have on older adult's perceptions. As a result, it was necessary to create novel stimuli for the study.

For the thesis, the original intention was to adopt a participatory approach to the design of the stimuli (Darin Ellis & Kurniawan, 2009) whereby the intended audience are involved in the design and development of the materials. However, due to the COVID-19 pandemic this was not possible and data collection was only possible via online platforms. As a result, older adults were still involved in the design of the study materials but instead the designs were created, and feedback was sought virtually from older adults who made suggestions for improvements via video call, telephone and email. This is a valuable step in the co-design of the experimental stimuli as it ensures the information is clearly understood and accessible by representatives of the required sample (Clemensen, Rothmann, Smith, Caffery, & Danbjorg, 2017). To strengthen this process, a pilot study was conducted prior to large scale data collection and feedback was invited from this pilot sample. These two steps are vital to improving the validity of the study (Malmqvist, Hellberg, Möllås, Rose, & Shevlin, 2019).

In the design of the stimuli, an evidence-based approach was used to ensure the stimuli was valid, but also appeared as a credible source of information for older adults. The text was created based on previous literature which ensures the information provided to participants as part of the study was valid (Apolinário-Hagen et al., 2018). Furthermore, guidance was also followed for the formatting of the text. Namely, advice was followed from the National Institute on Ageing regarding how to present the textual information in terms of writing and formatting the text. For example, ensuring the text is 'left justified', with suitable spacing between letters, creating contrasts between colours used, and limiting line length (National Institute on Aging, 2008).

Along with the design of the stimuli itself, the study design was also optimised for older adult participants. Older adults were given no time constraints to read the information to ensure they were able to read and re-read the information to ensure full understanding. This is deemed important as for older adults interpreting online health messages, greater time reading online text leads to better understanding and recall (Bol et al., 2016).

The collective result of these procedures in creating the experimental stimuli resulted in a credible source of information, which was trustworthy, believable and improved awareness and knowledge of MMHIs. This was evidenced through the fact that mean scores for questions

asking participants about the trustworthiness, believability and whether participants had learnt anything as a result of reading the information all scored very highly.

The findings from this study confirms that the NHS webpage as a suitable method of information delivery and should therefore be a consideration for future research. This is a significant finding as older adults rely more and more on the internet to locate and obtain health-related information (Tennant et al., 2015). Furthermore, as older adults struggle to differentiate between low and high quality health information, by using the NHS website as a delivery method for the information (Manafò & Wong, 2012), it allows older adults to have greater trust in the information as the NHS are a key healthcare provider in the UK. Indeed, in study 1, participants stated that facilitating use of MMHIs through trusted sources (such as the NHS) is a credible way to improve uptake.

9.9 Limitations

This thesis presents four studies which provide novel and useful findings; however, limitations of the thesis must also be acknowledged. The samples recruited within this thesis were all over 50 years of age, retired and live in the UK. While it is a strength of the thesis that the eligibility criteria remained consistent throughout, there is a bias to be considered. The recruitment strategies described in Chapters, 5, 6 and 7 (studies 2, 3 and 4) relied on online recruitment panels in order to access the participant pools required. Furthermore, in order to understand the psychological barriers, rather than structural barriers to use in chapter 4 (study 1), it was a condition of participation that participants self-identified as technology users. As a result, all participants have assumed technology use in order to access the online questionnaires and to meet the inclusion criteria of study 1. As all participants were technology users, it is unlikely that the results presented in this thesis will generalise to older adults who do not have access to technology, or do not have sufficient computer literacy. While older adults are increasing in their technology use, there is still a large number who do not use ubiquitous technologies, and so consideration as to how MMHI can be made more accessible.

A second limitation with regard to the sample is the classification of older adult. This thesis considered older adults to be over 50 years of age and retired as this takes into account both the chronological age and additional social factors of ageing. The definition of an ‘older adult’ is widely debated (Righi et al., 2017; Vines et al., 2015; Wiles, 1987), and while the multidimensional criteria used within this thesis are considered a strength of the research, it is

possible that had a 'typical' definition of later-life been adopted for the thesis, different results may have been found.

Another limitation of this thesis is the fact that each study consisted of a cross-sectional design, including the qualitative study which captured a snapshot of participant perceptions of MMHIs following a demonstration. There is therefore an absence of longitudinal testing of older adult's use of MMHIs. While this thesis is the first to consider the factors affecting/determining uptake of MMHIs for older adults, it remains unclear as to whether addressing all of these factors leads to improved *actual* uptake as rates of uptake in study 3 were too low to include in any analysis. This thesis shows that current use of MMHIs within a general population of older adults was low, however it would be useful to longitudinally follow participants through following an acceptance facilitating intervention whereby they increase their knowledge base and awareness of MMHIs and measure treatment preference, and then longitudinally measure treatments accessed. This would allow for analysis which confirm the determinants of *actual* use, rather than factors that are associated with intentions to use.

Furthermore, conclusions drawn from this thesis should be considered with caution. The thesis presents results from samples of participants with low or an absence of symptoms of depression. While it is important to consider the view of older adults in general because they may require the use of MMHIs in the future, investigating attitudes towards and intentions to use MMHIs in a clinical sample would provide insight into the appraisal of MMHIs within older adults seeking treatment for depression. However, due to the fact that there was no access to a clinical psychologist throughout the project, the decision was made to not recommend digital treatments to clinical samples of older adults due to ethical concerns.

9.10 Future Research

This thesis has explored the factors associated with uptake and use of MMHIs for older adults. However, there remains a number of questions and potential future research opportunities to better understand how technology can be utilised to improve mental health care delivery for older adults. Firstly, the thesis focussed on MMHIs for depression and it is recognised that MMHIs have found some success for a number of mental health disorders including eating disorders (Linardon, Shatte, Messer, Firth, & Fuller-Tyszkiewicz, 2020), anxiety (Gratzer et al., 2015) and Obsessive Compulsive Disorder (Wootton, Titov, Dear, Spence, & Kemp, 2011). Therefore, there is scope to replicate the findings of this thesis to determine the use of MMHIs for other prevalent mental health disorders in later life. As digital health is already prevalent in

a number of physical health domains, it is important that as uptake of MMHIs continues and implementation within primary care becomes more widespread, MMHIs are considered for a range of mental health issues where there is an evidence base for efficacy and not limited to depression.

Furthermore, an issue highlighted within this thesis is the role that healthcare professionals may have in the uptake of MMHIs for older adults. While studies have examined the attitudes towards MMHIs and their use within clinical practice, future research should specifically identify the attitudes and intentions of healthcare professionals at towards recommending MMHIs to older adults. This may highlight further barriers to the ubiquity of MMHI use within mental health care.

Additionally, as discussed previously, the thesis focus' on older adult samples in the general population. While symptoms of depression were not identified as a predictor of attitudes in chapter 5 (study 2), future research should aim to replicate the findings within a clinical sample of older adults. This would improve the validity of the findings as it would ensure the conclusions of the thesis could be applied to treatment seeking older adults.

Finally, this thesis examined the effect of knowledge-based stimuli on determinants of older adult's use of MMHIs. While the study shows that stimuli designed like an NHS webpage may be a potential way in which to provide information regarding MMHIs to older adults, given that the study was conducted online, an avenue of future research could be to further these findings by presenting such stimuli in more ecologically valid locations. One study has presented the stimuli in primary care locations such as GP practices while participants waited for their GP appointment (Ebert et al., 2015). This would be a fruitful avenue for research as older adults rely on their GP for health care information and findings from this thesis suggest they are a trusted source of information.

9.11 Conclusion

This thesis has contributed to previous research within the digital mental health literature by taking a theoretical approach to improving perceptions of MMHIs. The thesis has used a mixed methods approach to highlight the importance of perceptions of data security, attitudes and ease of use in the uptake of MMHIs. This thesis also demonstrates that the Technology Acceptance Model is a suitable model to apply to the context of uptake of MMHIs for older adults and contributes to the wide body of literature identifying ease of use and perceived usefulness and attitudes as important factors in determining intentions to use. As digital mental health interventions become more widely accepted throughout healthcare, applying the findings of this thesis might contribute towards alleviating exclusion of older adults from their use and ensuring that the needs of older adults are considered equally to other age groups.

Appendices

Appendix 1: Interview Schedule

1. Please tell me about the types of technology you use?
    a. What are your reasons for using them?
2. Please describe any issues or difficulties you have encountered when using technology.
3. If an issue arose regarding your technology, how would you go about finding support or advice?
    a. Why would you use this resource?
    b. Does this affect your confidence in using this technology?
4. What is your interpretation of mental health?
5. Among older adults, what do you think the attitude toward mental health is?
    a. What has formed these attitudes?
6. How would you go about seeking information about mental health?
7. How do you think depression is treated?
8. What are your attitudes towards sharing information about mental health using technologies which could be accessed by qualified members of the health service?
9. Describe your willingness to learn how to use new or different technology if it had a benefit on your mental health?
10. What is your familiarity with NHS services for mental health?
11. What is your current knowledge of mental health treatments/interventions?
    a. Are you aware of any that use technology or the Internet?
12. What are your thoughts towards a mental health intervention that was delivered through technology? Such as a mobile based app or the Internet?
    a. Why?
    b. What benefits do think this might bring?
    c. What negative aspects are there to this?
    d. For it to be useful to you, what would it include?
    e. Delivered through Internet vs seeing face to face?

Appendix 2: Questionnaire Items

Construct		Item
Perceived Usefulness	PU1	I find mobile health to be useful to improve my life in general
	PU2	Using a mobile mental health application would improve my life quickly
	PU3	I would find mobile mental health applications useful
	PU4	Using a mental health application would save time
	PU5	I think that mobile mental health applications provide very useful services
	PU6	Mobile mental health applications are an improvement to the services it supersedes
Perceived Ease of Use	PEOU1	I find it easy to get the benefits from a mobile mental health application
	PEOU2	Using a mental health application will be complicated
	PEOU3	Using a mobile mental health application will take a lot of effort
	PEOU4	I find mobile mental health applications are easy to use
	PEOU5	Learning to operate a mobile mental health application would be / is easy for me
Perception of Data Security	SEC1	If I was using a mobile app for mental health support… All information I disclose would be treated in strict confidence
	SEC2	If I was using a mobile app for mental health support… I would fear that confidential information would fall into the wrong hands
	SEC3	If I was using a mobile app for mental health support… I believe no one could access my data without my permission
E-Awareness	EA1	To what extent are you aware of mobile interventions for mental health?
	EA2	How much experience do you have using a mobile app for mental health?
Attitudes	ATT1	Using a mobile mental health application would be Good/Bad
	ATT2	Using a mobile mental health application would be Pleasant/unpleasant
	ATT3	Using a mobile mental health application would be Beneficial/harmful
	ATT4	Using a mobile mental health application would be Favourable/unfavourable
Behavioural Intention	BI1	I can imagine trying a mobile-based depression intervention for my worries, problems and fears

	BI2	I can imagine using a mobile-based depression intervention if offered to me
	BI3	I would recommend a mobile-based depression intervention to a friend
	BI4	I would be willing to pay for an mobile-based depression intervention

Appendix 3: EFA Pattern Matrix

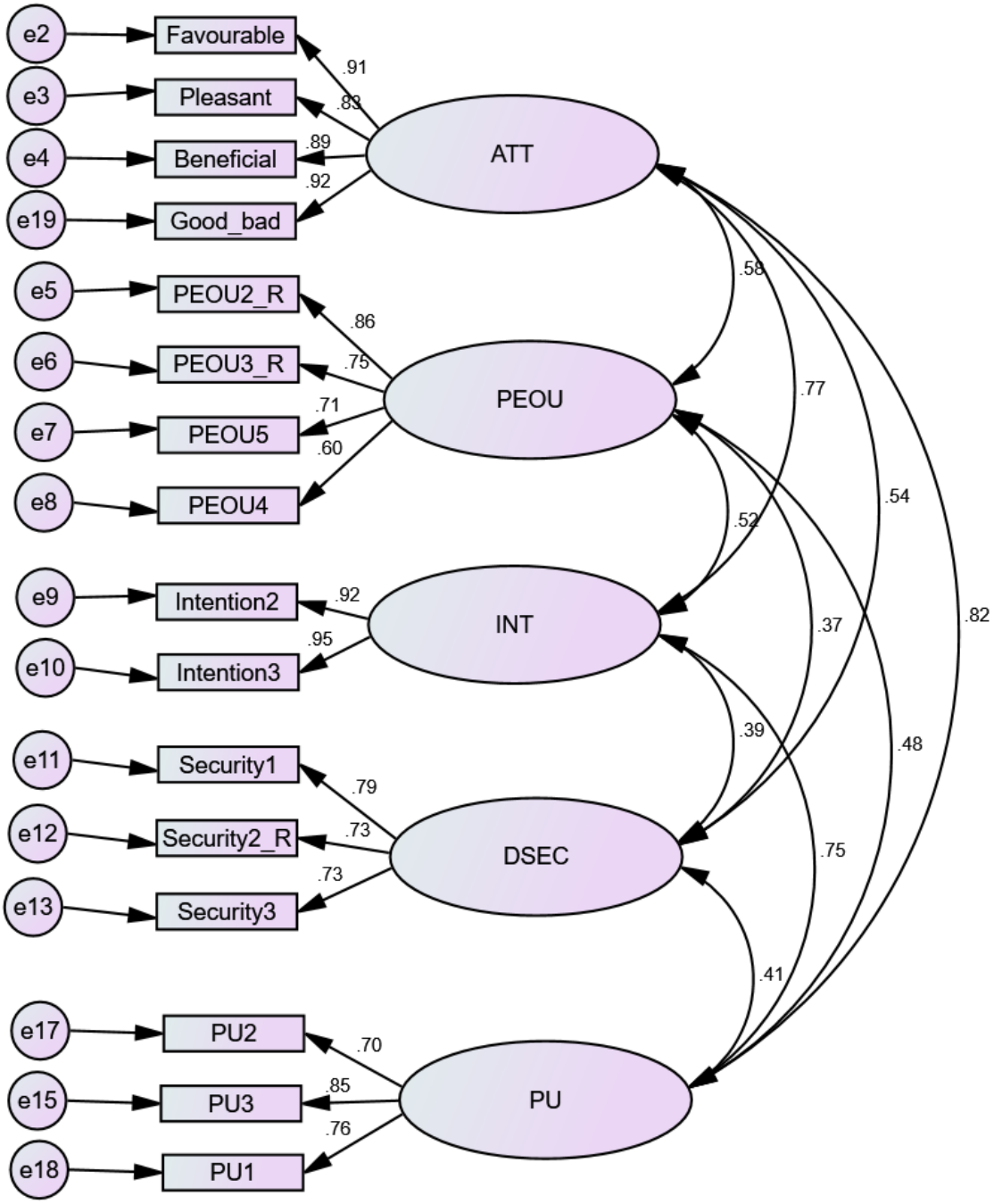
Pattern Matrix[a]					
	Factor				
	1	2	3	4	5
PEOU2_R	.876				
PEOU3_R	.764				
PEOU5	.678				
PEOU4	.599				
ATT1-Favourable/unfavourable		.872			
ATT2-Good/Bad		.855			
ATT3-Beneficial/Unbeneficial		.850			
Using a mobile mental health application would be...		.681			
PU3			.844		
PU2			.654		
PU1			.611		
Security2_R				.765	
Security1				.756	
Security3				.732	
INT2					.999
INT3					.735

Extraction Method: Maximum Likelihood.

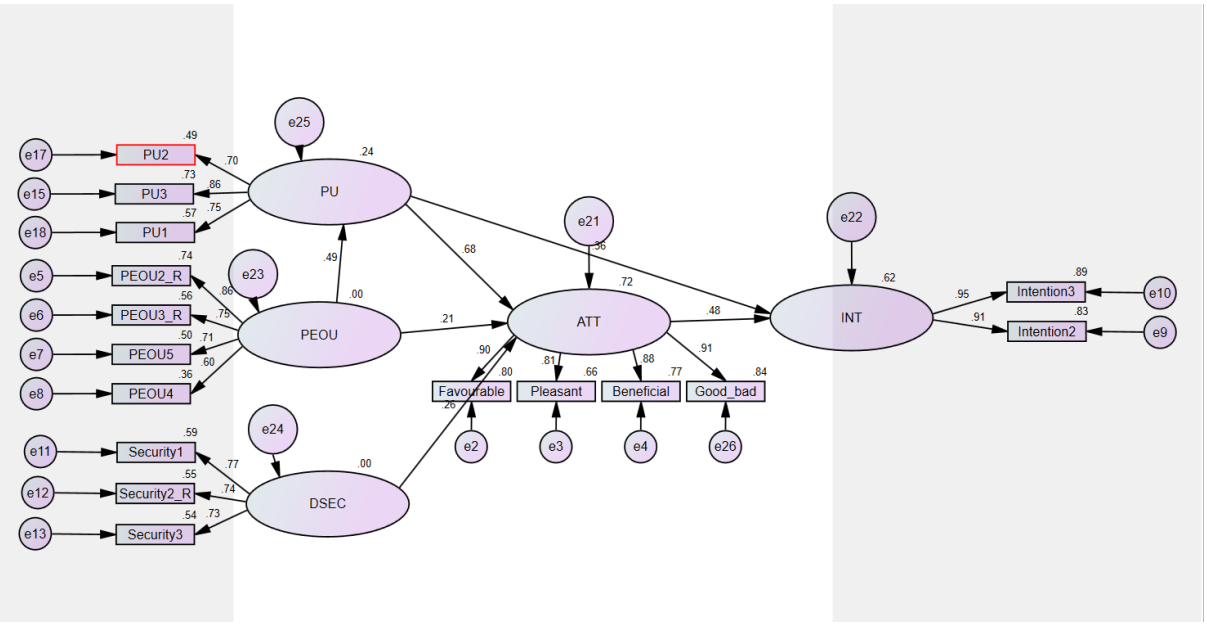
Rotation Method: Promax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

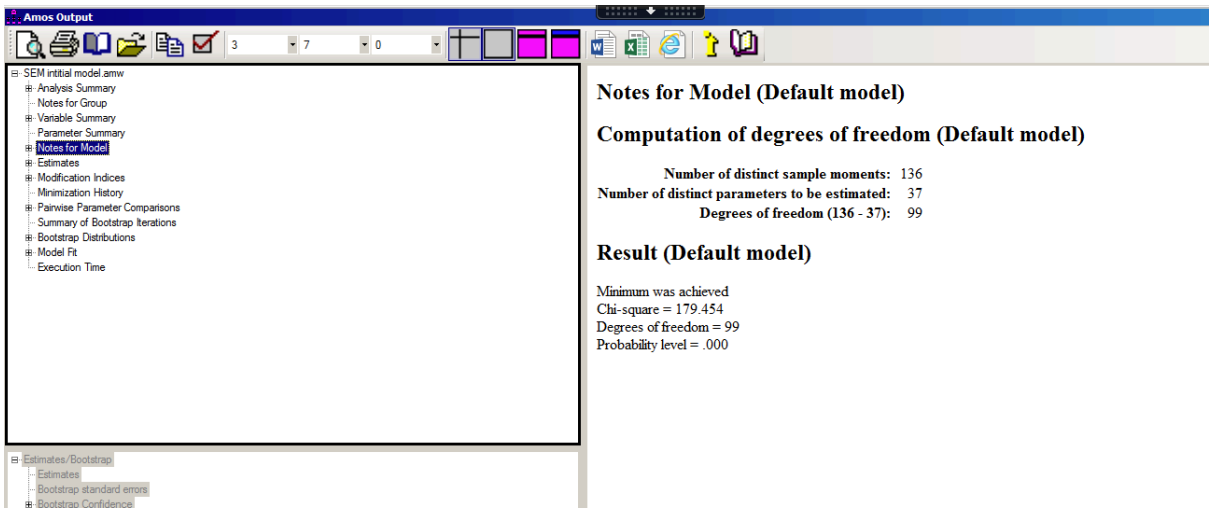
Appendix 4: CFA with Standardised Item Loadings



Appendix 5: Structural Model Output



Appendix 6: Default Model AMOS Output



Appendix 7: Standardised Regression Weights AMOS output

Standardized Regression Weights: (All - Default model)

			Estimate
PU	<---	PEOU	.492
ATT	<---	PU	.684
ATT	<---	DSEC	.256
ATT	<---	PEOU	.210
INT	<---	ATT	.477
INT	<---	PU	.358
PEOU4	<---	PEOU	.599
PEOU5	<---	PEOU	.707
PEOU3_R	<---	PEOU	.750
PEOU2_R	<---	PEOU	.862
Intention3	<---	INT	.945
Intention2	<---	INT	.909
Security3	<---	DSEC	.732
Security2_R	<---	DSEC	.745
Security1	<---	DSEC	.771
Pleasant	<---	ATT	.809
Favourable	<---	ATT	.896
Beneficial	<---	ATT	.879
PU2	<---	PU	.697
PU3	<---	PU	.857
PU1	<---	PU	.755

Good_bad	<---	ATT	.915

Standardized Regression Weights: (All - Default model)

Parameter			Estimate	Lower	Upper	P
PU	<---	PEOU	.492	.384	.613	.008
ATT	<---	PU	.684	.599	.781	.007
ATT	<---	DSEC	.256	.163	.364	.005
ATT	<---	PEOU	.210	.084	.303	.013
INT	<---	ATT	.477	.336	.638	.006
INT	<---	PU	.358	.173	.514	.015
PEOU4	<---	PEOU	.599	.469	.682	.023
PEOU5	<---	PEOU	.707	.622	.790	.009
PEOU3_R	<---	PEOU	.750	.673	.798	.034
PEOU2_R	<---	PEOU	.862	.814	.904	.013
Intention3	<---	INT	.945	.921	.962	.023
Intention2	<---	INT	.909	.872	.932	.021
Security3	<---	DSEC	.732	.652	.794	.021
Security2_R	<---	DSEC	.745	.673	.820	.007
Security1	<---	DSEC	.771	.703	.849	.011
Pleasant	<---	ATT	.809	.757	.856	.006
Favourable	<---	ATT	.896	.867	.930	.006
Beneficial	<---	ATT	.879	.853	.906	.010
PU2	<---	PU	.697	.630	.750	.013
PU3	<---	PU	.857	.802	.890	.032

PU1	<---	PU	.755	.690	.805	.012
Good_bad	<---	ATT	.915	.886	.936	.019

Appendix 8: Mediation Analysis AMOS outputs.

Mediation – 2000 Bootstraps

DSEC – ATT – INT

User-defined estimands: (All - Default model)

Parameter	Estimate	Lower	Upper	P
A x B	.131	.058	.243	.000

PU – ATT – INT

User-defined estimands: (All - Default model)

Parameter	Estimate	Lower	Upper	P
A x B	.129	.056	.228	.001

PEOU – ATT – INT

User-defined estimands: (All - Default model)

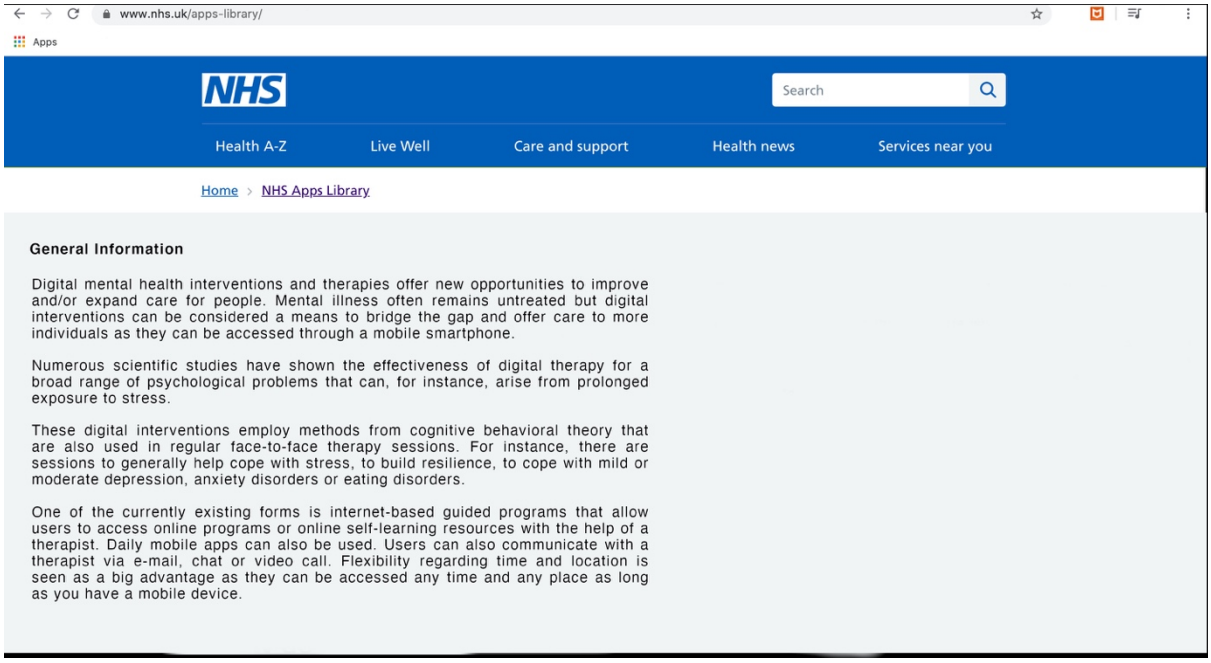
Parameter	Estimate	Lower	Upper	P
A x B	.470	.250	.682	.001

PEOU – PU – ATT

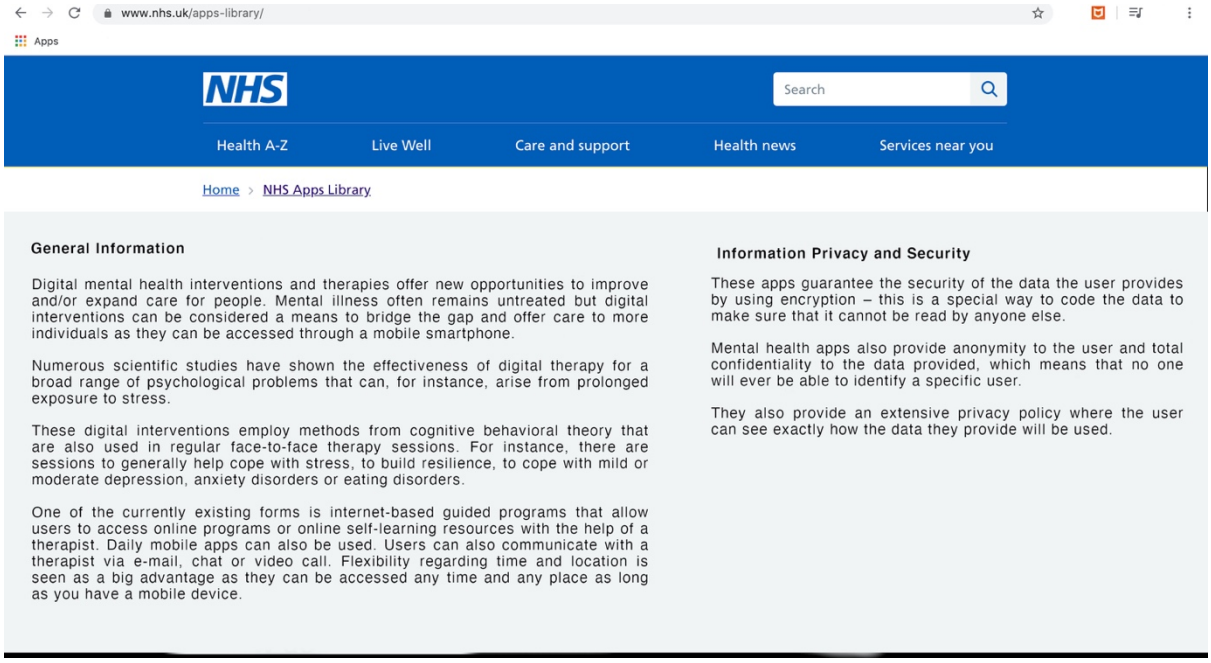
User-defined estimands: (All - Default model)

Parameter	Estimate	Lower	Upper	P
A x B	.514	.394	.678	.000

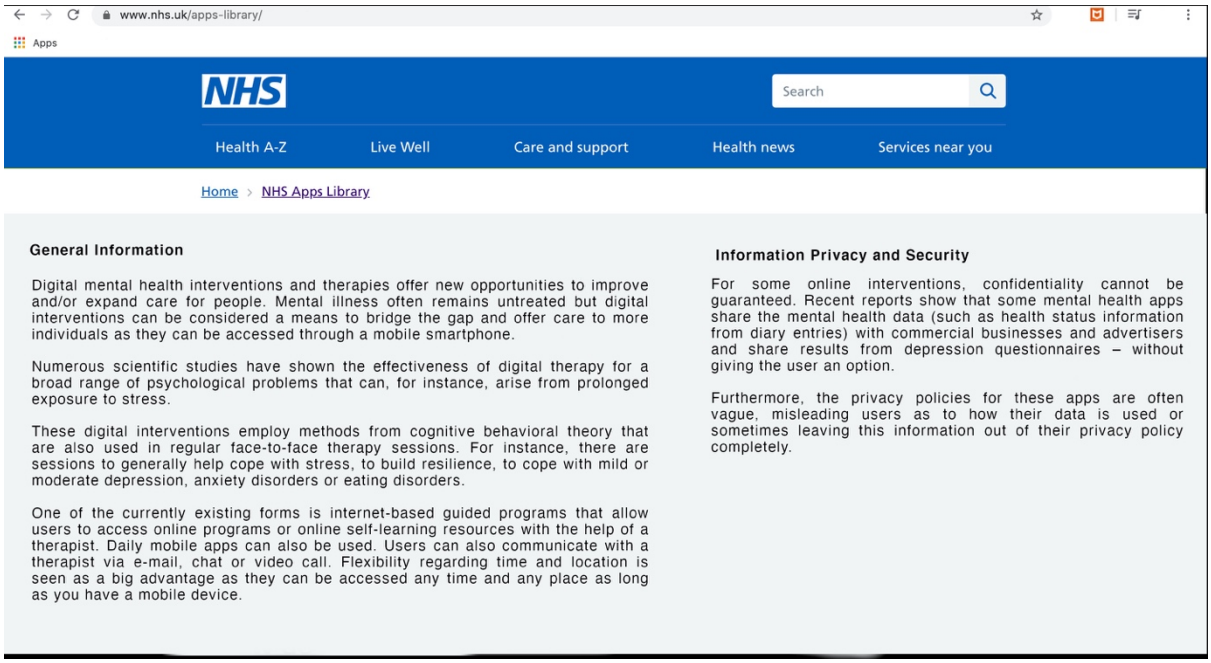
Appendix 9: Control Condition



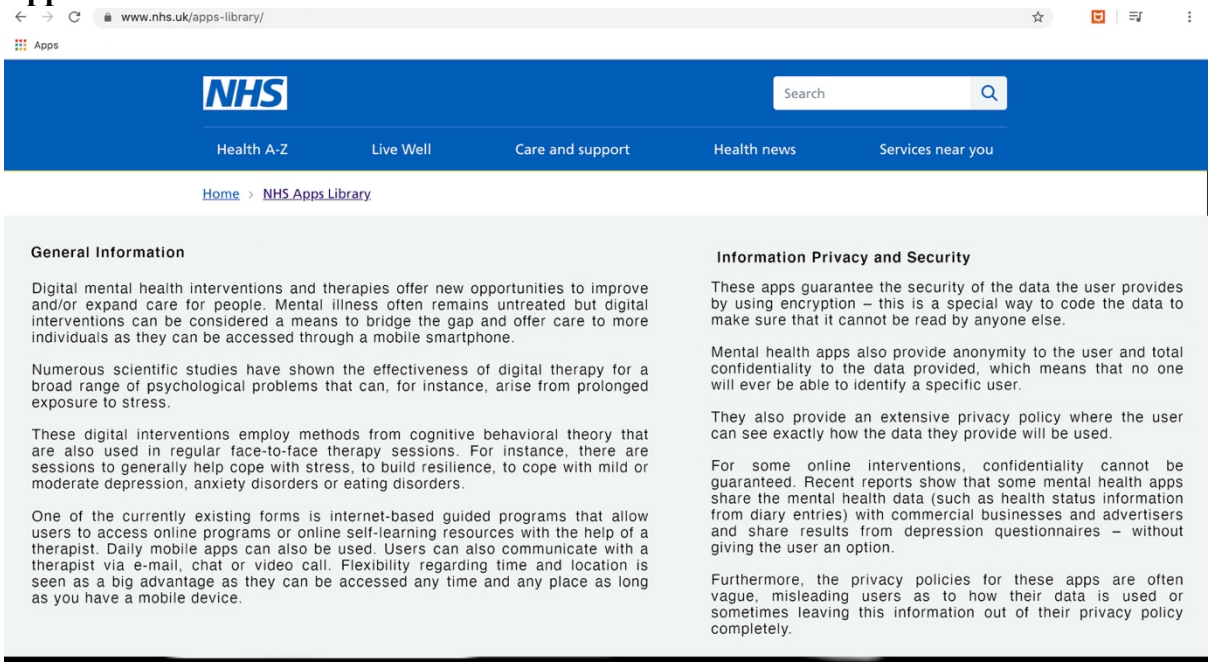
Appendix 10: Positive Condition



Appendix 11: Negative Condition



Appendix 12: Combined Condition



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